HiSoftware Compliance Sheriff™
Contrast Ratios
Table of Contents

TABLE OF FIGURES ................................................................................................................................................. 2
ACCESSIBILITY REQUIREMENTS .............................................................................................................................. 3
   CSU ATI ACCESSIBILITY REQUIREMENTS ............................................................................................................... 3
   WCAG ........................................................................................................................................................................ 3
RATIO CALCULATION ............................................................................................................................................. 4
   LUMINOSITY ............................................................................................................................................................ 4
   LUMINOSITY RATIO ........................................................................................................................................... 4
APPLICATIONS TESTED ........................................................................................................................................... 5
   EXAMPLE PAGE .................................................................................................................................................. 5
   EXAMPLE CODE ............................................................................................................................................... 6
RESULTS COMPARISON .......................................................................................................................................... 7
   COMPLIANCE SHERIFF RESULTS ...................................................................................................................... 7
   JUICY STUDIO: COLOUR CONTRAST ANALYSER RESULTS ........................................................................... 8
   SNOOK.CA RESULTS ..................................................................................................................................... 9
CONCLUSION ....................................................................................................................................................... 10
WORKS CITED ...................................................................................................................................................... 11

Table of Figures

Figure 1 - Luminance Functions ............................................................................................................................ 4
Figure 2 - Contrast Ratio ......................................................................................................................................... 4
Figure 3 - Good and Bad Contrast Ratio Example Tables .................................................................................... 5
Figure 4 - Compliance Sheriff Show Instances .................................................................................................... 7
Figure 5 - Juicy Studio Firefox plug in .................................................................................................................. 8
Figure 6 - Snook.ca Colour Contrast Check Calculator ....................................................................................... 9
Accessibility Requirements

CSU ATI Accessibility Requirements

The campuses of California State University are following the modified checkpoints provided by HiSoftware Inc. based off of the Section 508 requirements. (Section508.gov, 2010) These checkpoints have been carefully put together into groups following the same Section 508 standards, though many of the individual checkpoints are from WCAG. In this case in particular the G18 checkpoint is being used to follow the same standards set by Section 508.

The WCAG G18 checkpoint in the Compliance Sheriff software is a compiled checkpoint that looks to see that the contrast ratio of 4.5:1 is being met on a page. This means that the rule of the checkpoint contains a call to a method in the tool that checks the font style, size and color. The code will confirm if bold is being used, if the text is part of a header, as well as the size of the text and if it is in percent (pc), point (pt), or pixel (px). Because WCAG G18 specifically references that the parameters are specific to text that is less than 18 point (if not bold) and less than 14 point (if bold) it will skip over any other text. Once it has completed the comparison check for size and style it will then perform the color contrast check using the formula found on the G18 page. (G18, 2012) Then following the rest of the rule, it will make sure there is more text content on the page before it gives a ‘visual check’ result where a human is needed to verify that even if the contrast ration falls within acceptable parameters it still needs to be seen by a human to confirm it can actually be seen.

WCAG

The Web Content Accessibility Guidelines, better known as WCAG, have gone through revisions to keep up with changing technologies. In version 2.0 of the Web Accessibility Content Guidelines, G18 ensures that a contrast ratio of at least 4.5:1 exists between text (and images of text) and its background. (G18, 2012) This ratio is the minimum needed to be seen by those with color deficiencies. This applies to any technology that produces a visual output and relates to success criterion 1.4.3, which states that:

“The intent is to provide enough contrast between text and its background so that it can be read by people with moderately low vision (who do not use contrast-enhancing assistive technology). For people without color deficiencies, hue and saturation have minimal or no effect on legibility as assessed by reading performance (Knoblauch et al., 1991). Color deficiencies can affect luminance contrast somewhat. Therefore, in the recommendation, the contrast is calculated in such a way that color is not a key factor so that people who have a color vision deficit will also have adequate contrast between the text and the background.”
(Success-Criterion, 2012)

Where the success criterion cover the purpose of the guideline, G18 goes into the details of how to ensure the text on a page is differentiable from its background. By using success criterion 1.4.3 it sets the minimum requirement for text that is less than 18 point (if not bold) and less than 14 point (if bold) to have a ratio of 4.5:1. This checkpoint only checks for the minimum required to see colored text on a background, for text sizes larger than 18 point (if not bold) and 14 point (if bold) it relaxes that ratio to 7:1 in accordance with success criterion 1.4.5. (G18, 2012)
Ratio Calculation

There are many tools out there that, like Compliance Sheriff, calculate the color contrast ratios on a site. The way these tools calculate the ratio is to take the styles and colors from the page source, and identify the red, green and blue scale or RGB defined for each element on the page. These colors are defined as hex values within the HTML of the page, for example, #FFFFFF is solid white, while #000000 is solid black. Once all of the color values are attained, the calculation for Luminosity and be performed to determine the brightness of the content.

Luminosity

There are several processes to determine the brightness of text found on a page. The first step involves calculating the relative luminance of each letter or word by determining the 8bit value of the HEX of a color. Without going into code detail there are several methods of coding that can be done to determine this value. Once the HEX value of a color is converted into an 8bit sequence of numbers it will then be divided by 255 as shown in the equation below. (G18, 2012)

\[
L = 0.2126 \times R + 0.7152 \times G + 0.0722 \times B \quad \text{where } R, G \text{ and } B \text{ are defined as:}
\]

- if \( R_{sRGB} \leq 0.03928 \) then \( R = R_{sRGB} / 12.92 \) else \( R = ((R_{sRGB} + 0.055)/1.055)^{2.4} \)
- if \( G_{sRGB} \leq 0.03928 \) then \( G = G_{sRGB} / 12.92 \) else \( G = ((G_{sRGB} + 0.055)/1.055)^{2.4} \)
- if \( B_{sRGB} \leq 0.03928 \) then \( B = B_{sRGB} / 12.92 \) else \( B = ((B_{sRGB} + 0.055)/1.055)^{2.4} \)

and \( R_{sRGB}, G_{sRGB}, \text{ and } B_{sRGB} \) are defined as:

- \( R_{sRGB} = R_{8bit} / 255 \)
- \( G_{sRGB} = G_{8bit} / 255 \)
- \( B_{sRGB} = B_{8bit} / 255 \)

The \(^{\text{th}}\) character is the exponentiation operator.

Figure 1 - Luminance Functions

The above equations from the WCAG G18 rule contains conditional statements as to which calculation is to be used for different situations. This means that, depending on the value returned by dividing the 8bit value by 225, one of two equations will be used to determine the colors luminosity. Once this luminosity is known the ratio calculation can be performed.

Luminosity Ratio

After you have completed calculating the Luminosity for both the foreground (text) and background you will need to determine which of the two is lighter in color. Once you have established this you will enter the two Luminosity values into the equation bellow. (G18, 2012)

\[
(L_1 + 0.05) / (L_2 + 0.05), \quad \text{where}
\]

- \( L_1 \) is the relative luminance of the lighter of the foreground or background colors, and
- \( L_2 \) is the relative luminance of the darker of the foreground or background colors.

Figure 2 - Contrast Ratio

So long as the resulting fraction is equal to or greater than 4.5:1 you have met a color contrast that an individual with moderate to low vision can make out on a page.
Applications Tested

There are many tools that use the WCAG 2.0 G18 calculations to determine color contrast ratio, some of them are available for free while others are paid for. Although the WCAG 2.0 standards have been in place for some time there are still applications that have not updated from the WCAG 1.0 standards and should be avoided in the interest of being fully compliant. The W3C website has a page dedicated to all of the tools that can be used for accessibility. (G18, 2012) The following pages use the Juicy Studio Firefox plugin as well as Snook.ca recommended by the W3C site and compare them to the results of the Compliance Sheriff application. Using a provided example page from the W3C site, the three tools were used to check the code provided.

It is important to note that all of the tools used in this comparison report do not calculate the contrast ratio of text sitting on top of an image on top of a defined background color. If the color behind the image is white and you place white text on the image, you will not pass the contrast check because it can only see the white text on a white background. Alternately, if you have black text on an image that sits on a white background your check will pass, even if the image is black as well. These tools only look for the colors defined in the HTML code of the page, and have no capability to detect the color of an image.

Example Page

The following test examples were performed on a page created by the W3C and is at the following URL for reference: http://www.w3.org/WAI/wcag-curric/sam27-0.htm

The page contains a table layout with one good example of color contrast (seen below on the left) and one bad example of color contrast (bottom right). For a better idea of the HEX codes mentioned in the ratio calculation above the page source has also been provided below.
Example Code

```html
<TABLE Summary="A layout table is used because CSS is not well implemented in most browsers yet">
  <TR>
    <TD align="center" ><IMG SRC="img/facehap.gif" ALT="Happy face: good choice!"></TD>
    <TD align="center" ><IMG SRC="img/facemad.gif" ALT="Angry face: bad choice!"></TD>
  </TR>
  <TR>
    <TD>
      <div style="height: 200; width:200; border: thin groove black; background: #ffffff;">
        Text color - Example 1
        <P> <SPAN style="font-family: arial; font-size: 18pt;">Product List</SPAN><br>
        <SPAN style="font-family: arial; font-size: 16pt; font-style: italic;">Printers</SPAN><br>
        &nbsp;&nbsp;Laser<br>
        &nbsp;&nbsp;&nbsp;&nbsp;Model 1 - 4 ppm - 2 bin<br>
        &nbsp;&nbsp;&nbsp;&nbsp;Model 2 - 10 ppm - 3 bin</P>
      </div>
    </TD>
    <TD>
      <div style="height: 200px; width:200px; border: thin groove black; background: #cccc99; ">
        Text color - Example 2
        <P> <SPAN style="font-family: arial; font-size: 18pt; color: #99cc99;">Product List</SPAN><br>
        <SPAN style="font-family: arial; font-size: 16pt; font-style: italic; color: #99cc66;">Printers</SPAN><br>
        &nbsp;&nbsp;Laser<br>
        &nbsp;&nbsp;&nbsp;&nbsp;Model 1 - 4 ppm - 2 bin<br>
        &nbsp;&nbsp;&nbsp;&nbsp;Model 2 - 10 ppm - 3 bin</P>
      </div>
    </TD>
  </TR>
</TABLE>
```
Results Comparison

Compliance Sheriff Results

The results of the Compliance Sheriff tool were the most promising of all of the tests, and of all of the tools used was the easiest to identify failures. The results of the scan showed all of the text in the Example 2 panel that is less than 18pt font as a failure.

Figure 4 - Compliance Sheriff Show Instances

The text larger than 18pt was not picked up not because of the tool but because the G18 guideline actually states that it is only for text smaller than 18pt. Compliance Sheriff does allow for the addition of Success Criterion 1.4.5 guideline check which will ensure that a ratio of 7:1 exists between all text in the foreground and the background color. (Success-Criterion, 2012) The purpose of this comparison is to meet the Success Criterion 1.4.3 which is the minimum ratio needed for those with color deficiencies. Therefore, the test for the higher standards of a ratio of 7:1 will not be checked in this report.
**Juicy Studio: Colour Contrast Analyser Results**

The Juicy Studio: Color Contras Analyzer is an add-on provided for free by Mozilla for the Firefox browser. It is easy to install and easy to use, simply right click on the page you want to test and select the Juicy Studio Accessibility option and the Colour Contrast Analyser. It will open a new page with the number of failures shown in a table at the top and then a detailed table below. The detailed table in the lower section of the page will provide the element, the parent nodes, a sample and the HEX values of the foreground and background colors. The final column will show the calculated contrast ratio as well as if it passes or fails.

For the test of the example page provided by W3C, the page was loaded in Firefox and the Juicy Studio add-on was executed, the results came back passing the entire page. The free tool had calculated out the colors and luminosity correctly; however it did not now that the background color in the Example 2 table had changed. So instead of calculating the color contrast ratio for the HEX color of #cccc99 it used the plain white background that is stated for the background of the content table of the page.

![Juicy Studio Firefox plug in](image)

**Summary of Failures**

<table>
<thead>
<tr>
<th></th>
<th>Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminosity Contrast Ratio</td>
<td>0</td>
</tr>
<tr>
<td>Difference in Brightness</td>
<td>0</td>
</tr>
<tr>
<td>Difference in Colour</td>
<td>0</td>
</tr>
</tbody>
</table>

In this case the tool may be free and easy to use, however it misses the example page entirely. It worked fine as long as there was not a change in background color declared on the page, which would only be useful for a very simple page, not the average designed webpage.
Snook.ca Results
This tool is one that appears on a recommended tools site linked too by the WCAG G18 page, and was chosen because it resembled the most common measurement methods of all of the recommended free tools. (Johansson, 2007) Snook.ca, like many others, requires the user to enter in the individual color HEX codes they are planning on using for their page. It cannot scan the code of a page and pull the colors itself. However, it performs the calculations accurately and has an easy to read result table.

Colour Contrast Check

![Figure 6 - Snook.ca Colour Contrast Check Calculator](image)

The web site does a good job of showing not just the ratio as well as an example of the colors provided. The major drawback for this site however is it can only check the difference between two colors you provide. It cannot scan a page and determine the background and foreground colors defined, and having to go through each individual color is slow.
Conclusion

Based on results and usability it is clear that the Compliance Sheriff application is the best tool to use when checking for contrast ratio. Not only did it correctly analyze the results of the example page provided by W3C, it also had the easiest to understand results with red boxes around each of the words not meeting the 4.5:1 ratio. Additionally it could check for other ratios accepted by the W3C site, like the one defined in Success Criterion 1.4.5.

Snook.ca was a nice free alternative; it did not require a download and provided a simple table of results. The website is easy to navigate too and use, however you are entering each individual HEX code for each color used. If you are attempting to test a page that is already created or contains complex changes in background and text color, it will take extensive work to check all of the ratios.

The Juicy Studio add-on, although very easy to install and use, did not provide accurate results. It did not catch that the table containing the example had a different background color than the rest of the page, and rather than using the example color it used the page background color. Also, if you do not already have the Firefox browser installed on your machine it will need to be downloaded as well as the add-on.

In reviewing the results for each of the applications against the test page, there are several trends that can be found. One is that the simpler the application the more complicated it is to get the results you are looking for. There is also the fact that free to use applications either requires a downloaded add-on for the browser or you have to enter values into an applet one at a time. No matter what tool you use, once you have the values entered or the page checked the results take some looking into. Compliance Sheriff goes the extra mile to assist with the identification of the failures as they appear on the page, but most other applications assume you know HTML. Compliance Sheriff is easier than others to understand, but no matter what tool you use, they all require an understanding of what a contrast ratio is and why it is important.
Works Cited


