

Colour Contrast Calculations

To calculate the contrast ratio, we first normalise the sRGB colour values. Each colour channel X (R, G or B) ranges from 0 to 255, so normalisation simply means dividing X by 255.

$$X_{sRGB} = \frac{X}{255}$$

We then convert the normalised sRGB values to linear **RGB** using the standard sRGB gamma-correction function.

$$\mathbf{X} = \begin{cases} \frac{X_{sRGB}}{12.92} & \text{for } X_{sRGB} \leq 0.03928, \\ \left(\frac{X_{sRGB} + 0.055}{1.055} \right)^{2.4} & \text{for } X_{sRGB} > 0.03928. \end{cases}$$

Next, we calculate the relative luminance of the colour.

$$L = 0.2126 \cdot \mathbf{R} + 0.7152 \cdot \mathbf{G} + 0.0722 \cdot \mathbf{B}$$

Finally, we compute the contrast ratio between the two luminance values.

$$CR = \begin{cases} \frac{L_1 + 0.05}{L_2 + 0.05} : 1 & \text{for } L_1 > L_2, \\ \frac{L_2 + 0.05}{L_1 + 0.05} : 1 & \text{for } L_2 > L_1, \\ 1 : 1 & \text{for } L_1 = L_2. \end{cases}$$

Sources for these calculations:

<https://www.w3.org/TR/WCAG20/#contrast-ratiodef>

<https://www.w3.org/TR/WCAG20/#relativeluminancedef>

The AA standard for colour contrast is the lowest standard we should aim for. This have the contrast between text and background at 4.5:1 and for large text 3:1.

The AAA standard has the value 7:1 and for large text 4.5:1.

Large text is set at 18 point or for bold text 14 point.

Source for colour contrasts:

<https://www.w3.org/TR/WCAG21/#contrast-minimum>

Example Calculation

$$\text{sRGB} = (0, 209, 211)$$

$$\text{sRGB} = (255, 102, 245)$$

$$R_{\text{sRGB}} = \frac{R}{255} = \frac{0}{255} = \underline{0}$$

$$R_{\text{sRGB}} = \frac{R}{255} = \frac{255}{255} = \underline{1}$$

$$G_{\text{sRGB}} = \frac{G}{255} = \frac{209}{255} = \underline{0.8196078431372549}$$

$$G_{\text{sRGB}} = \frac{G}{255} = \frac{102}{255} = \underline{0.4}$$

$$B_{\text{sRGB}} = \frac{B}{255} = \frac{211}{255} = \underline{0.8274509803921569}$$

$$B_{\text{sRGB}} = \frac{B}{255} = \frac{245}{255} = \underline{0.9607843137254902}$$

$$\mathbf{R}_1 = \frac{R_{\text{sRGB}}}{12.92} = \frac{0}{12.92} = \underline{0}$$

$$\mathbf{G}_1 = \left(\frac{G_{\text{sRGB}} + 0.055}{1.055} \right)^{2.4} = \left(\frac{0.8196078431372549 + 0.055}{1.055} \right)^{2.4} = \underline{0.637596874}$$

$$\mathbf{B}_1 = \left(\frac{B_{\text{sRGB}} + 0.055}{1.055} \right)^{2.4} = \left(\frac{0.8274509803921569 + 0.055}{1.055} \right)^{2.4} = \underline{0.6514056374}$$

$$L_1 = 0.2126 \cdot \mathbf{R}_1 + 0.7152 \cdot \mathbf{G}_1 + 0.0722 \cdot \mathbf{B}_1 = \underline{0.5030407713}$$

$$\mathbf{R}_2 = \left(\frac{R_{\text{sRGB}} + 0.055}{1.055} \right)^{2.4} = \left(\frac{1 + 0.055}{1.055} \right)^{2.4} = \underline{1}$$

$$\mathbf{G}_2 = \left(\frac{G_{\text{sRGB}} + 0.055}{1.055} \right)^{2.4} = \left(\frac{0.4 + 0.055}{1.055} \right)^{2.4} = \underline{0.1328683216}$$

$$\mathbf{B}_2 = \left(\frac{B_{\text{sRGB}} + 0.055}{1.055} \right)^{2.4} = \left(\frac{0.9607843137254902 + 0.055}{1.055} \right)^{2.4} = \underline{0.9130986518}$$

$$L_2 = 0.2126 \cdot \mathbf{R}_2 + 0.7152 \cdot \mathbf{G}_2 + 0.0722 \cdot \mathbf{B}_2 = \underline{0.3735531463}$$

$$CR = \frac{0.5030407713 + 0.05}{0.3735531463 + 0.05} : 1 = \underline{1.3 : 1}$$

This result is the same as we get from <https://webaim.org/resources/contrastchecker/>