Color Blending

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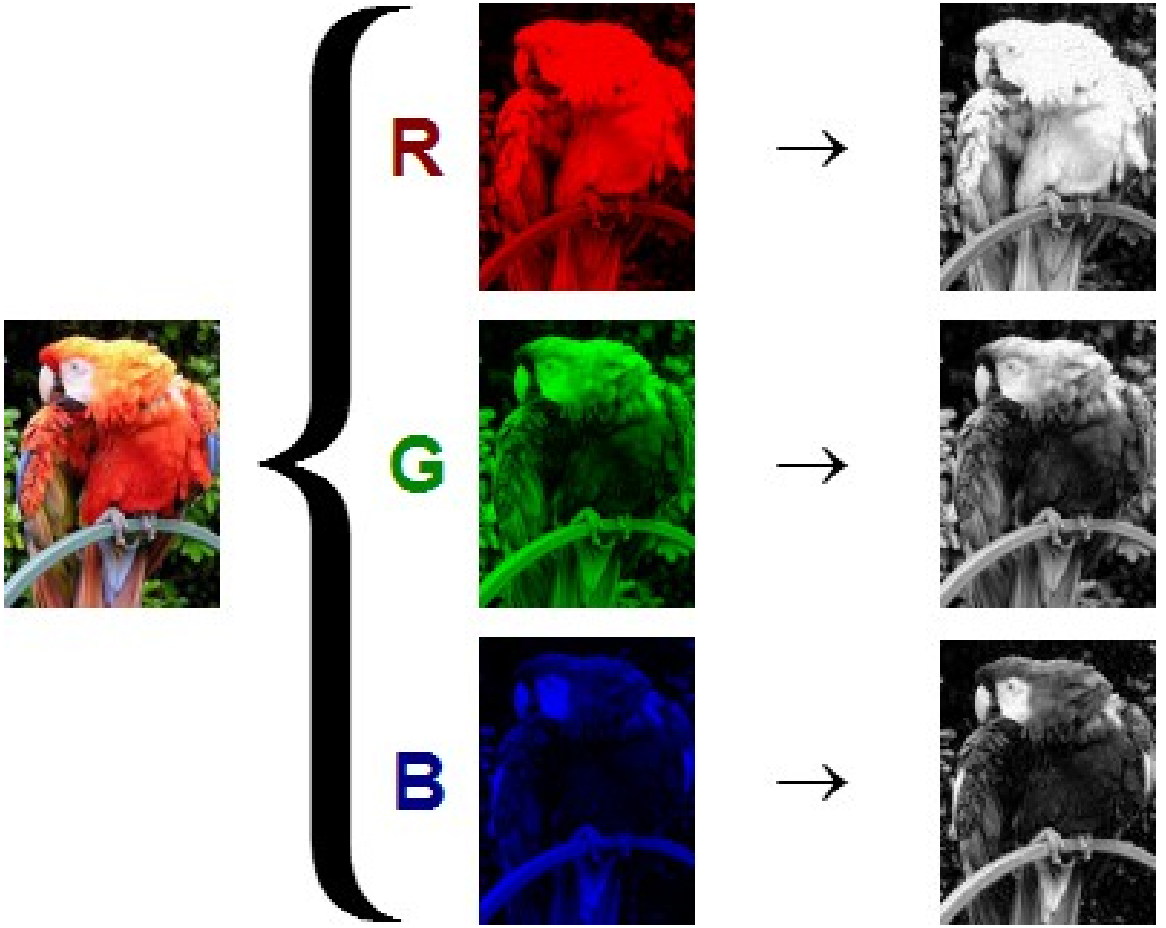
Colors (R,G,B,A?)

- 3 or 4 channels
- A channel contains information about that color.
- Values are usually kept in range from 0 to 255
- RGB(0,0,0) = black 
- RGB(255,255,255) = white 
- Value = the amount of the given color
- More like light than color

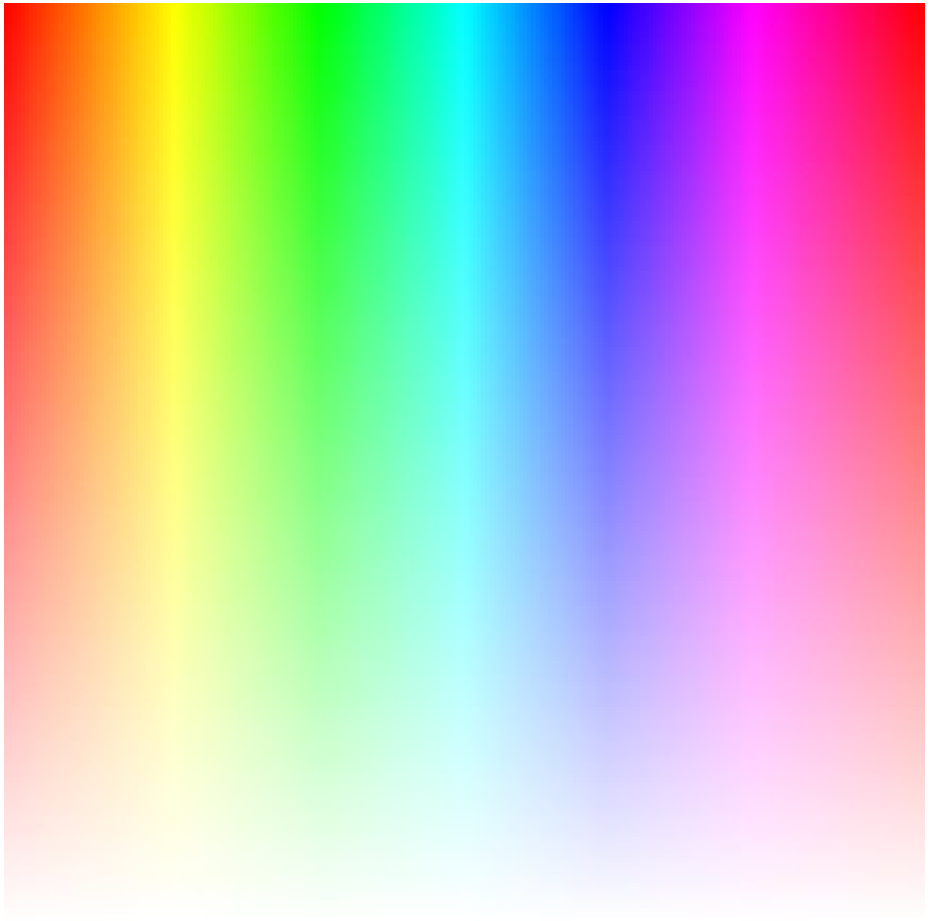
RGB



What about the A ?

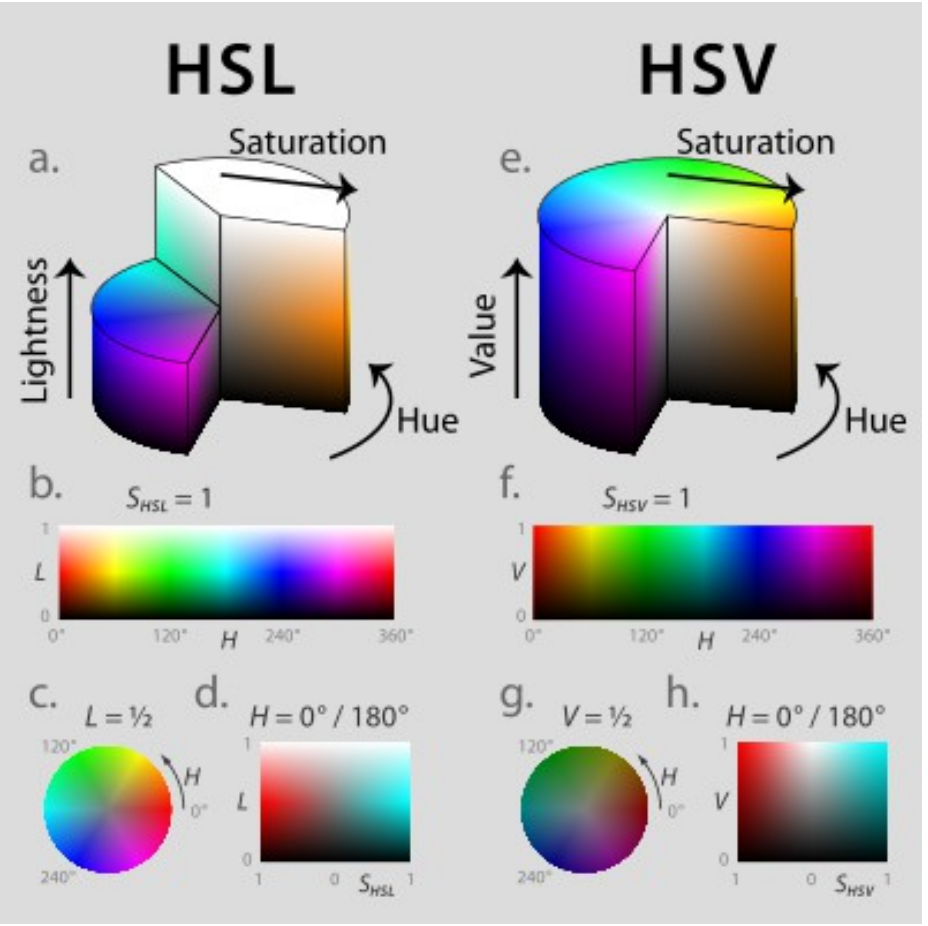
- A = stands for alpha channel
- The inventors named alpha after the Greek letter in the classic linear interpolation formula $\alpha A + (1-\alpha)B$.
- The alpha channel shows how „solid” the color is.
- More scientifically, it is an indicator on how to blend the given pixel with another pixel
- Allows for transparency in comupter graphics

Alpha



HSL and HSV

- Hue – The color
- Saturation – The purity of the color
- Lightness / Value – The brightness of a color



Computer graphics

- Color blending algorithms work with values in ranges [0 ... 1].
- Changing ranges is easy:

  [0 ... 255] / 255 = [0 ... 1]

  and

  ceil([0 ... 1] * 255) = [0 ... 255]

Why [0 ... 1]

- Computer graphics algorithms use properties of multiplication with numbers <= 1.

Photoshopping 101

- Color blending is extensively used in photo manipulation and photo correction.
- Manipulation is usually done in layers, giving each new layer a different way it blend with the other layers
- The 5 most basic and common:

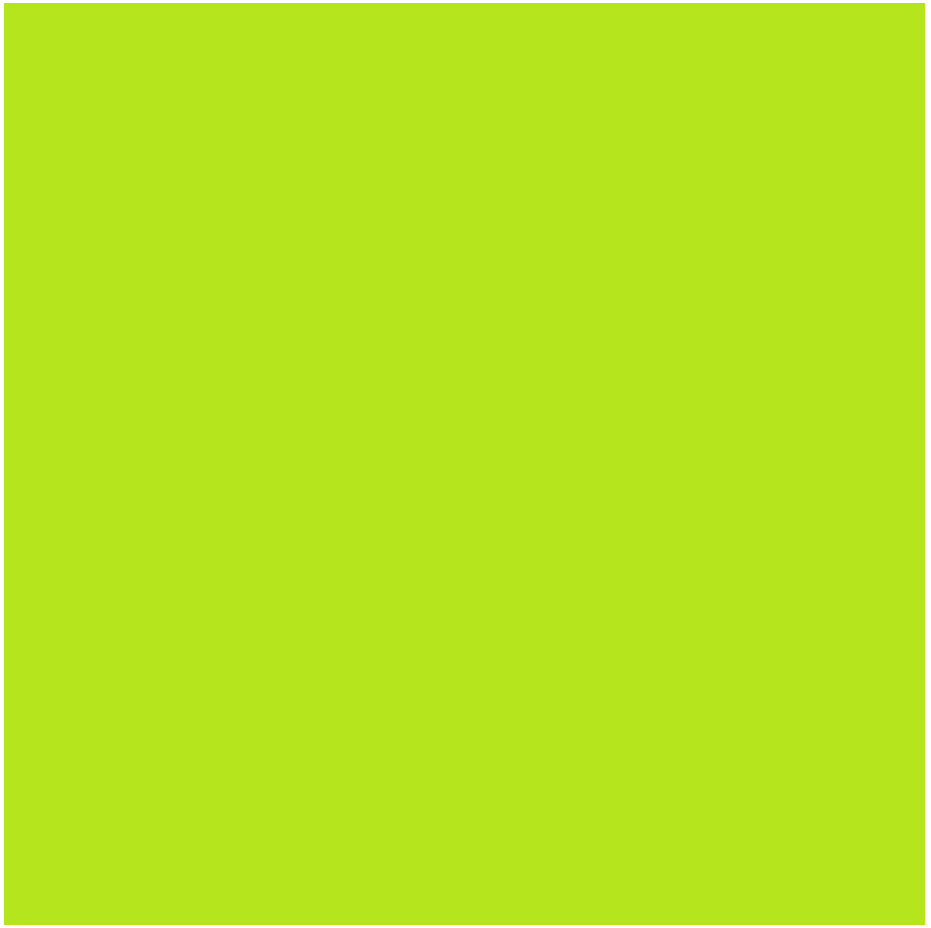
  Normal, Dissolve, Multiply, Screen, Overlay

Normal

- The most common blending mode of layers

$$f(a, b) = b$$

Normal



Dissolve

- Uses alpha channel values for blending, by using a random generator depending on the transparency.
- With high opacity most pixels are taken from the top layer and vice versa.

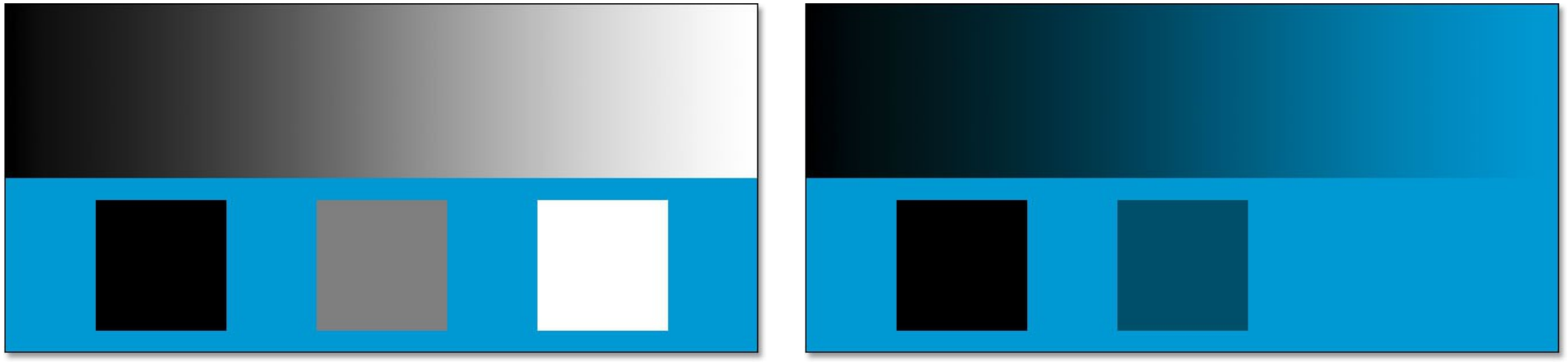
Dissolve (50% alpha)

Multiply

- Multiplies the pixel values with each other
- Gives the picture a darker color because of the properties of multiplication with values <= 1
- Good for making bright pictures darker

$$f(a,b) = ab$$

Multiply

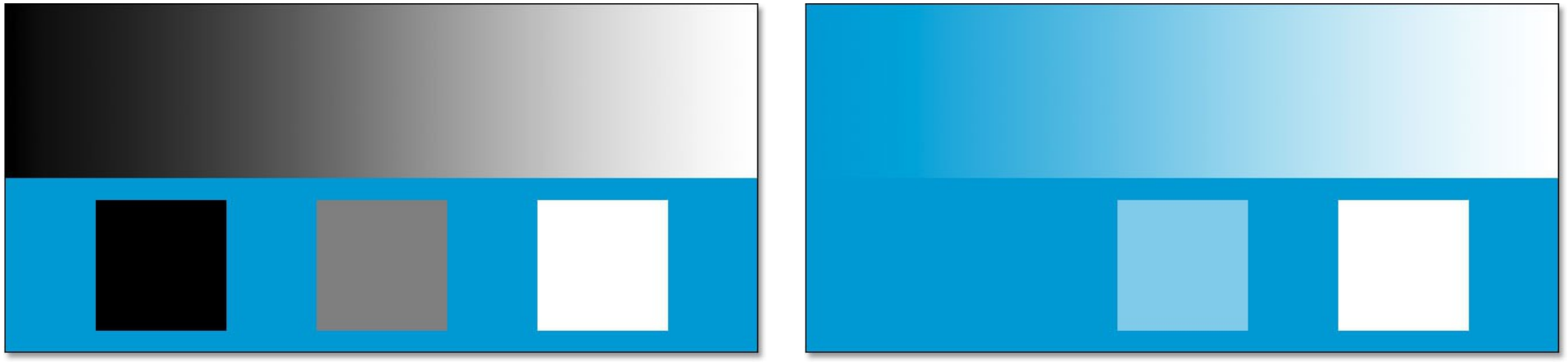


Screen

- Opposite of multiply.
- Lightens the picture up. Good for making very dark pictures lighter

$$f(a,b) = 1 - (1-a)(1-b)$$

Screen

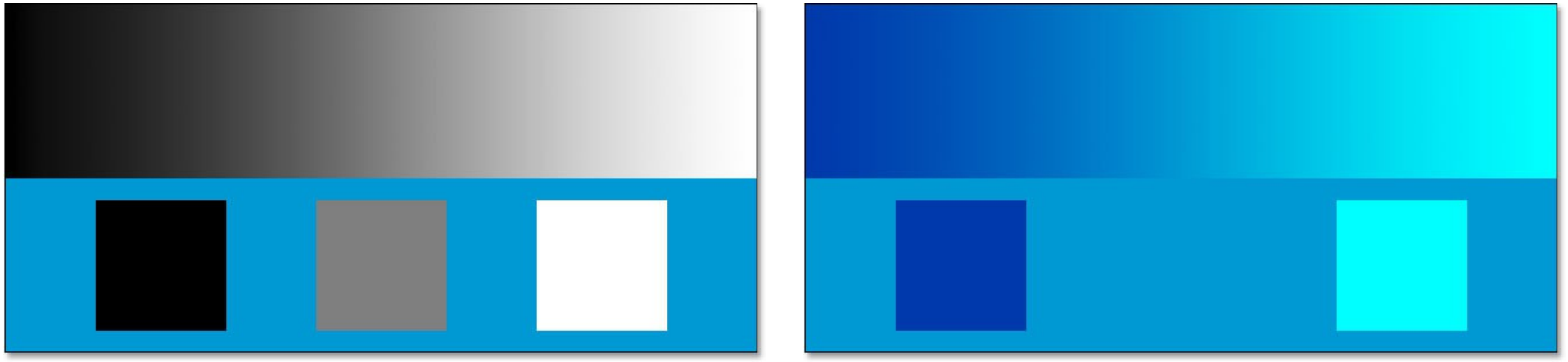


Overlay

- Is kind of a composite of multiply and screen
- It makes bright things darker
- Dark things brighter

$$f(a,b) = \begin{cases} 2ab, & \text{if } a < 0.5 \\ 1 - 2(1-a)(1-b), & \text{otherwise} \end{cases}$$

Overlay



Usefulness

Time for the alpha channel

- The process of rendering together a background and an image to create the illusion of partial or full transparency is called alpha compositing.
- It uses the colors of the pixels and also the values of the alpha channel to calculate the correct color to show.

Post multiplied alpha

$$\begin{cases} \mathrm{out}_A = 1 \\ \mathrm{out}_{RGB} = \mathrm{src}_{RGB}\mathrm{src}_A + \mathrm{dst}_{RGB}(1 - \mathrm{src}_A) \end{cases}$$

$$\begin{cases} \mathrm{out}_A = \mathrm{src}_A + \mathrm{dst}_A(1 - \mathrm{src}_A) \\ \mathrm{out}_{RGB} = \left(\mathrm{src}_{RGB}\mathrm{src}_A + \mathrm{dst}_{RGB}\mathrm{dst}_A\left(1 - \mathrm{src}_A\right)\right) \div \mathrm{out}_A \\ \mathrm{out}_A = 0 \Rightarrow \mathrm{out}_{RGB} = 0 \end{cases}$$

Pre-multiplied alpha

$$\begin{cases} \mathrm{out}_A = \mathrm{src}_A + \mathrm{dst}_A(1 - \mathrm{src}_A) \\ \mathrm{out}_{RGB} = \mathrm{src}_{RGB} + \mathrm{dst}_{RGB}\,(1 - \mathrm{src}_A) \end{cases}$$

- Pre-multiplied alpha blending has a few advantages over post multiplied alpha.

Pre vs post multiplied alpha

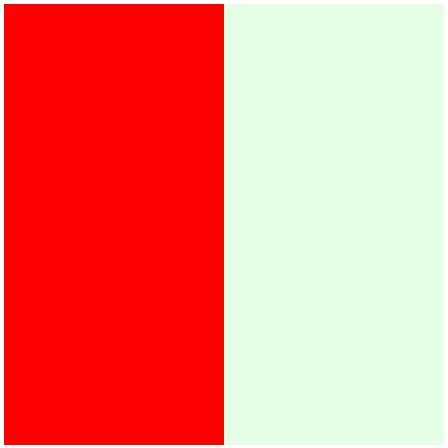
- There is a lot articles about pre- and post multiplied alpha. Next i will summarize what i understood

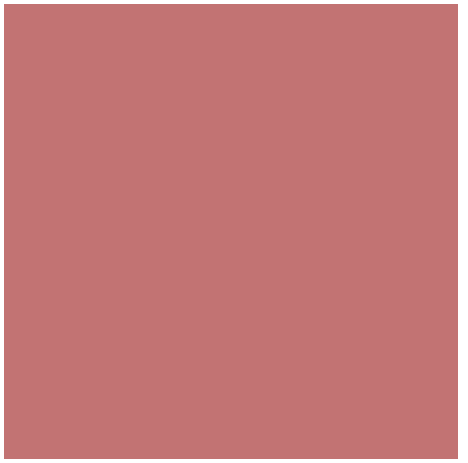
Advantages

- Pre-multiplied alpha is faster at runtime.
- Since the color is linked to the alpha channel beforehand then during runtime we decrease the amount of operations to do, therefore freeing up processor time.

Advantages

- Postmultiplied alpha can give a wrong color result when scaling down textures to lower resolutions.





Advantages

- Pre-multiplied alpha can be used to group up blending operations to its associativeness.
- a -> b -> c -> d
  tmp = b -> c
  a -> tmp -> d
- Post multiplied alpha does not support such operation.

Program demonstration

Questions ?

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