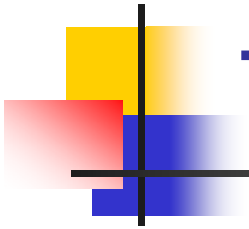
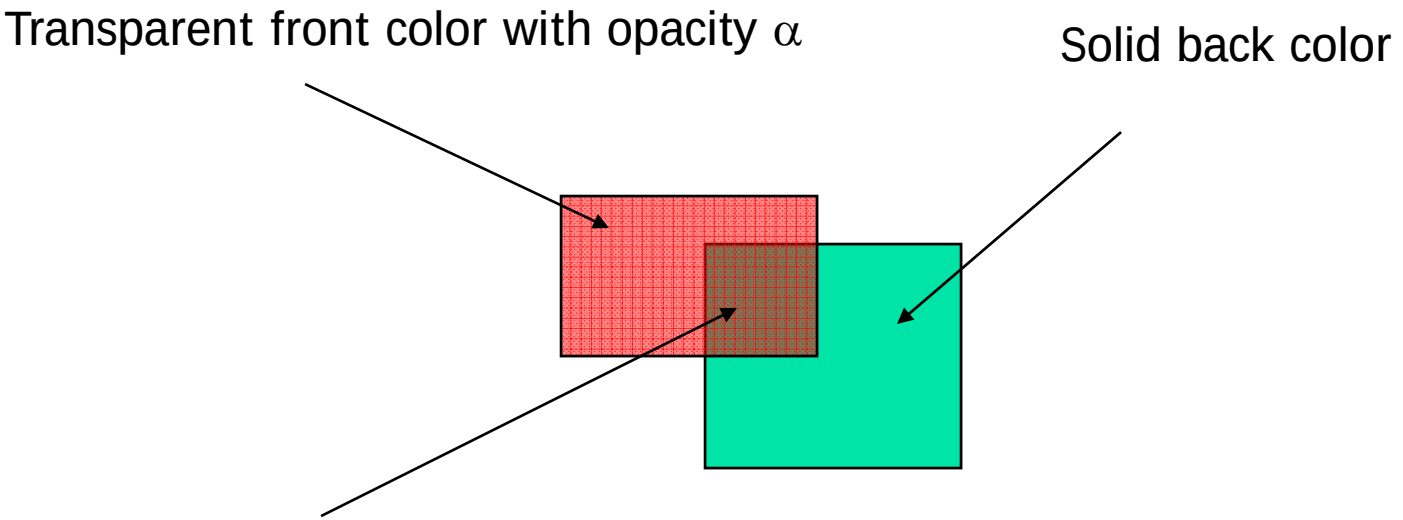


Transparency

- Blending colors
- Frame buffer limitations
- Compositing

Basic Alpha Blending

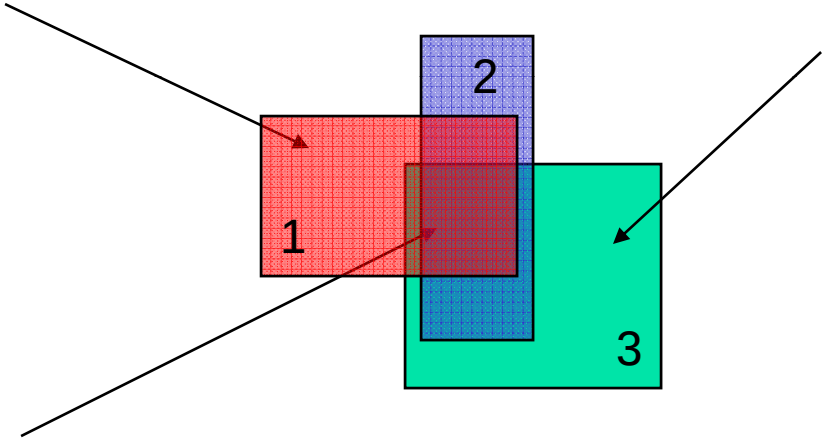


$$rgb = \alpha \cdot rgb_f + (1-\alpha) \cdot rgb_b$$

Basic Alpha Blending

Transparent front color with opacity α

Solid back color



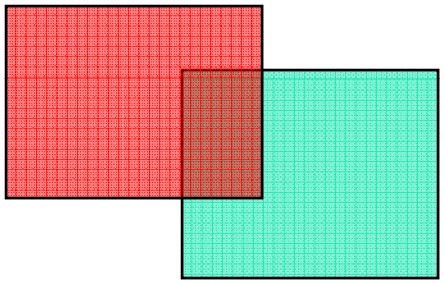
$$rgb = \alpha_1 \cdot rgb_1 + (1-\alpha_1) \cdot [\alpha_2 \cdot rgb_2 + (1-\alpha_2) \cdot rgb_3]$$

$$rgb = \alpha_1 \cdot rgb_1 + (1-\alpha_1) \cdot \alpha_2 \cdot rgb_2 + (1-\alpha_1) \cdot (1-\alpha_2) \cdot rgb_3]$$

Blending Alphas

Transparent front color with opacity α_f

Transparent back color with opacity α_b



$$rgb = \alpha_f \cdot rgb_f + (1-\alpha_f) \cdot \alpha_b \cdot rgb_b$$

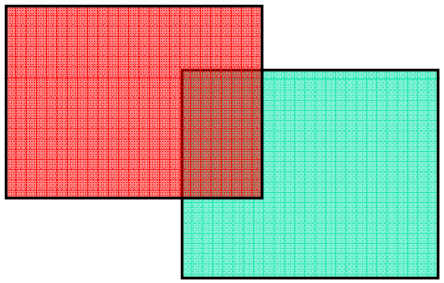
$$\alpha = \alpha_f + (1-\alpha_f) \cdot \alpha_b$$

Process in either front to back or back to front order
But can't insert surface between them later - why?

Premultiply alpha

Transparent front color with opacity α_f

Transparent back color with opacity α_b

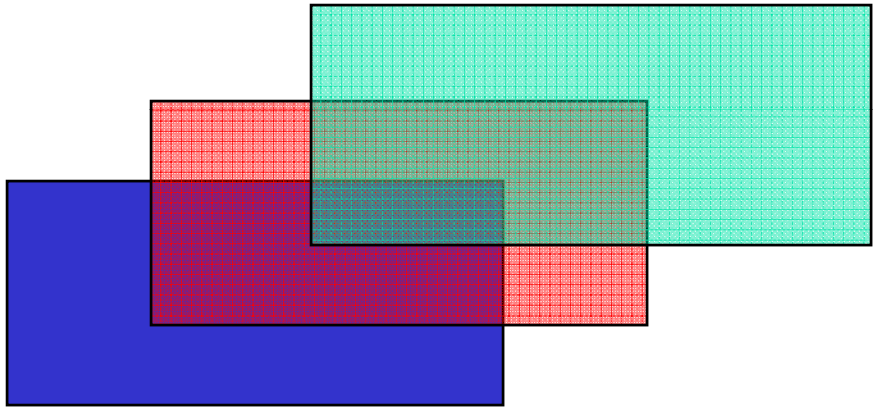


$$rgb = \alpha_f \cdot rgb_f + (1-\alpha_f) \cdot \alpha_b \cdot rgb_b$$

$$\alpha = \alpha_f + (1-\alpha_f) \cdot \alpha_b$$

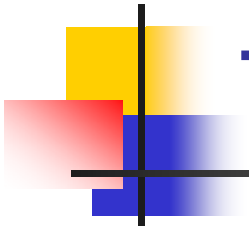
Notice - rgb always appears multiplied by it's α
Can store rgb's as *premultiplied* by α

Frame Buffer



- What about z value in depth buffer?

- Manage z-values: glDepthMask(GL_FALSE)

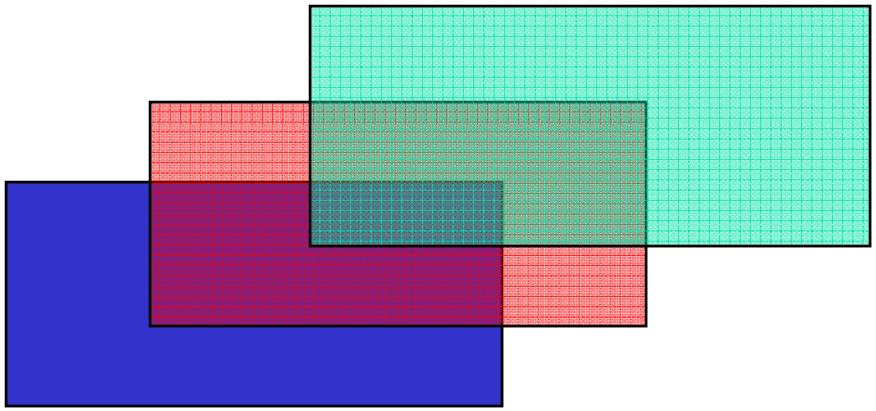


Transparency in OpenGL

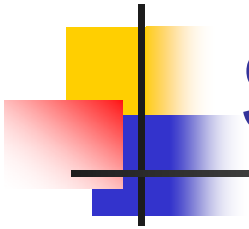
```
glEnable(GL_BLEND);
glBlendFunc(GL_SRC_ALPHA,GL_ONE_MINUS_SRC_ALPHA)

Draw polygon that has alpha values set

glDisable(GL_BLEND);
```

“Screendoor” transparency

- No blend - use alternating pixels from different surfaces



What about z value in depth buffer?



Stipple in OpenGL

Uses 32x32 pattern

```
-GLubyte halftone[] = {
0xAA, 0xAA, 0xAA, 0xAA, 0x55, 0x55, 0x55 , 0x55
...repeat 16 lines
}

glEnable(GL_POLYGON_STIPPLE);
glPolygonStipple(halftone);

draw polygon

glDisable(GL_POLYGON_STIPPLE);
```

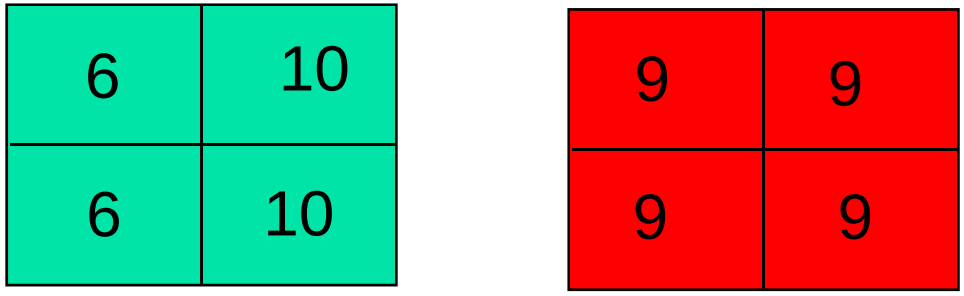
Compositing

- Without pixel z values
- With pixel z
- - use depth at pixel corners to interpolate partial coverage

Compositing

Z buffer: keep z values with color buffer

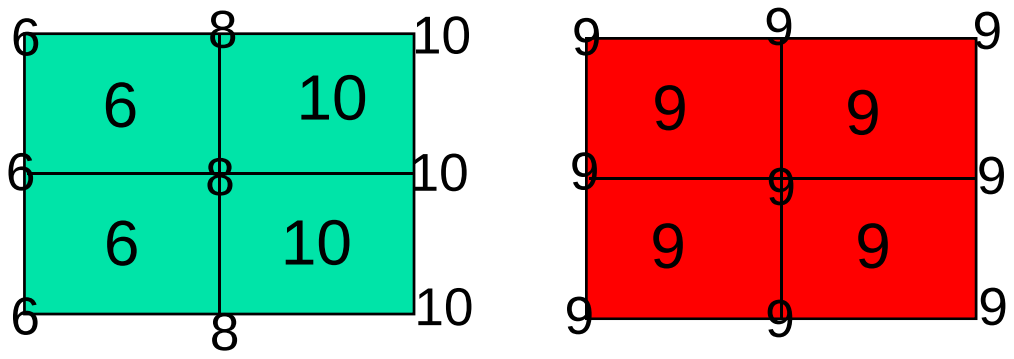
1. Compare z values at corresponding pixels
2. Keep all or nothing



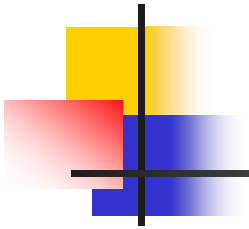
Compositing

Z buffer: keep z values with color buffer

1. Compare z values at corresponding pixels
2. Compute partial coverage:
   Interpolate corner z values
   Compare corner values for pixel and blend



Compositing



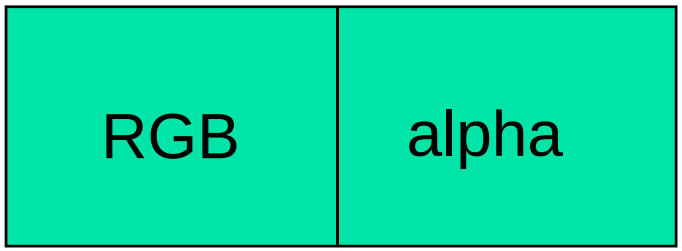
Alpha Channel

Value between 0 and 1

Combined partial coverage and transparency

Computed during rendering in front of a null background

2 1/2 D blend based on alpha of image in front



32 bit pixel values

Compositing - example