Chapter 13
Blending

How might you combine multiple elements?

New color A, old color B

Alpha Blending (OpenGL)

- Parameters:
  - s = source color
  - d = destination color
  - \( \alpha_s \) = source blend factor
  - \( d' = \alpha_s s + (1-\alpha_s)d \)

- Where
  - "Source" means "color/alpha of currently rendered primitive"
  - "Destination" means framebuffer value

Over operator

- \( d' = \alpha_s s + (1-\alpha_s)d \)
- Examples: \( \alpha_a = 1 \) \( \alpha_b = 0.4 \)

\[
\begin{align*}
A \text{ over } B: \quad & d' = 1 \cdot C_A + (1-1) \cdot C_B \\
B \text{ over } A: \quad & d' = 0.4 \cdot C_B + (0.6) \cdot C_A
\end{align*}
\]

Blending

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### Computer Graphics

#### Blending

**OpenGL Blending**

- **In OpenGL:**
  - Enable blending
    ```
    glEnable ( GL_BLEND )
    ```
  - Specify alpha channel for colors
    ```
    glColor4f ( r, g, b, alpha )
    ```
  - Specify blending function
    ```
    E.g. glBlendFunc( GL_SRC_ALPHA, GL_ONE_MINUS_SRC_ALPHA )
    ```
  - Other options available

**Caveats:**

- Note: alpha blending is an order-dependent operation!
  - It matters which object is drawn first AND Which surface is in front
  - For 3D scenes, this makes it necessary to keep track of rendering order explicitly
    ```
    E.g. always draw "back" surface first
    ```

#### Double Buffering

**Framebuffer:**

- Piece of memory where the final image is written

**Problem:**

- The display needs to read the contents, cyclically, while the GPU is already working on the next frame
- Could result in display of partially rendered images on screen

**Solution:**

- Have TWO buffers
  - Currently displayed (front buffer)
  - Render target for the next frame (back buffer)

**Front/back buffer:**

- Each buffer has both color channels and a depth channel
  - Important for advanced rendering algorithms
  - Doubles memory requirements!

**Switching buffers:**

- At end of rendering one frame, simply exchange the pointers to the front and back buffer
  ```
  GLUT toolkit: glutSwapBuffers() function
  ```

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