Blending, Anti Aliasing, Backface Culling

MEDIA DESIGN SCHOOL
GAME DEV

Blending

Blending

- Once an incoming fragment has passed all of the enabled fragment tests, it can be combined with the current contents of the color buffer in one of several ways.
- The default, is to overwrite the existing values
- Alternatively, you might want to combine the color present in the framebuffer with the incoming fragment color---a process called blending

Blending

- Blending is associated with the fragment's *alpha value.*
- Alpha is the fourth color component, and all colors in OpenGL have an alpha value
- it's a measure of translucency, and is what's used when you want to simulate translucent objects, like colored
- Glass or Water Surface for example

Blending

- Where color of a translucent object is a combination of that object's color with the colors of all the objects you see behind it
- OpenGL to do something useful with alpha, the pipeline needs more information than the current primitive's color (which is the color output from the fragment shader)
- It needs to know what color is already present for that pixel in the framebuffer

Blending

- In basic blending mode, the incoming fragment's color is linearly combined with the current pixel's color.
- *coefficients* control the contributions of each term
- those coefficients are called the *source-* and *destination-blending factors*

Blending

Final Colour = ($SrRs + DrRd$, //red

$SgGs + DgGd$, //green

$SbBs + DbBd$, //blue

$SaAs + DaAd$) //alpha

- (Sr, Sg, Sb, Sa) represent the source-blending **factors**. (Dr,Dg,Db,Da) represent the destination factors.
- (Rs,Gs, Bs,As) and (Rd,Gd, Bd,Ad) represent the **colors** of the source fragment and destinatio pixel respectively

Blending

- Controlling
  - Blending factors and
  - Blending Equation.

Blending

- Blending Factors
- You may call **glBlendFunc()** and choose two blending factors: the first factor for the source RGBA and the second for the destination RGBA
- void **glBlendFunc**(GLenum *srcfactor*, GLenum *destfactor*);

Blending

Constant	RGB Blend Factor	Alpha Blend Factor
GL_ZERO	$(0, 0, 0)$	0
GL_ONE	$(1, 1, 1)$	1
GL_SRC_COLOR	(R_s, G_s, B_s)	A_s
GL_ONE_MINUS_SRC_COLOR	$(1, 1, 1) - (R_s, G_s, B_s)$	$1 - A_s$
GL_DST_COLOR	(R_d, G_d, B_d)	A_d
GL_ONE_MINUS_DST_COLOR	$(1, 1, 1) - (R_d, G_d, B_d)$	$1 - A_d$
GL_SRC_ALPHA	(A_s, A_s, A_s)	A_s
GL_ONE_MINUS_SRC_ALPHA	$(1, 1, 1) - (A_s, A_s, A_s)$	$1 - A_s$
GL_DST_ALPHA	(A_d, A_d, A_d)	A_d

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Blending

- Blending Equation
- With standard blending, colors in the framebuffer are combined (using addition) with incoming fragment colors to produce the new framebuffer color.
- void **glBlendEquation**(GLenum *mode*);

Blending

Blending Mode Parameter	Mathematical Operation
GL_FUNC_ADD	$C_s S + C_d D$
GL_FUNC_SUBTRACT	$C_s S - C_d D$
GL_FUNC_REVERSE_SUBTRACT	$C_d D - C_s S$
GL_MIN	$\min(C_s S, C_d D)$
GL_MAX	$\max(C_s S, C_d D)$

- GL_FUNC_ADD by default

Addition and Subtraction

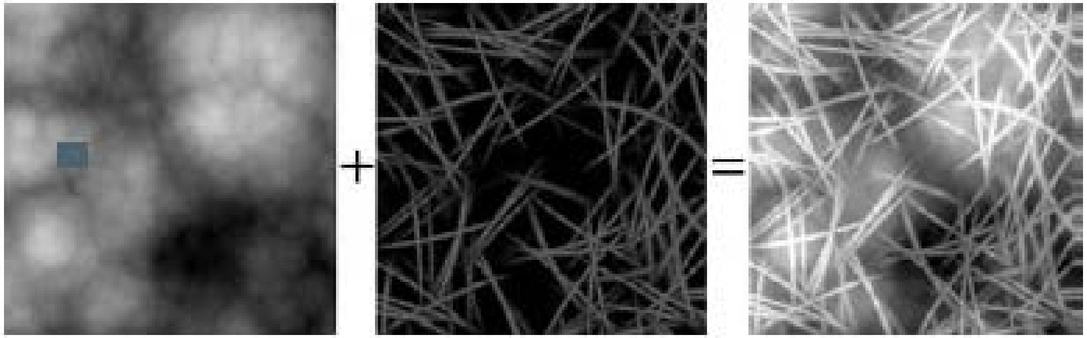


Figure 8.2: Adding source and destination color. Adding creates a brighter image since color is being added.

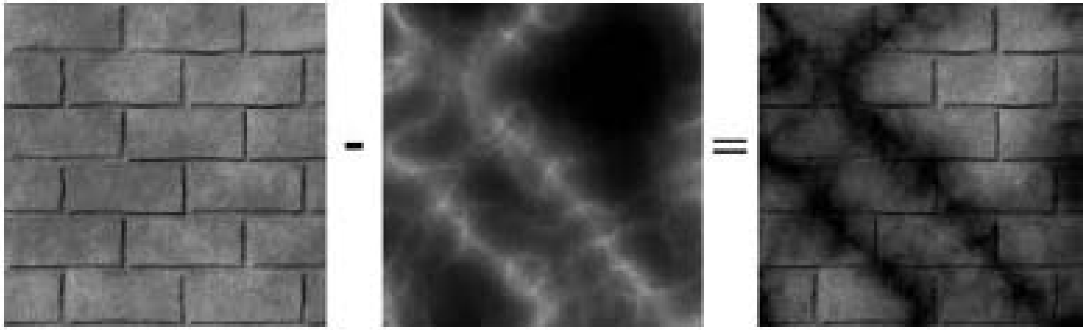


Figure 8.3: Subtracting source color from destination color. Subtraction creates a darker image since color is being removed.

Multiply

$$C = C_{src} \otimes F_{src} \boxplus C_{dst} \otimes F_{dst}$$

$$C = C_{src} \otimes (0,0,0) + C_{dst} \otimes C_{src}$$

$$C = C_{dst} \otimes C_{src}$$

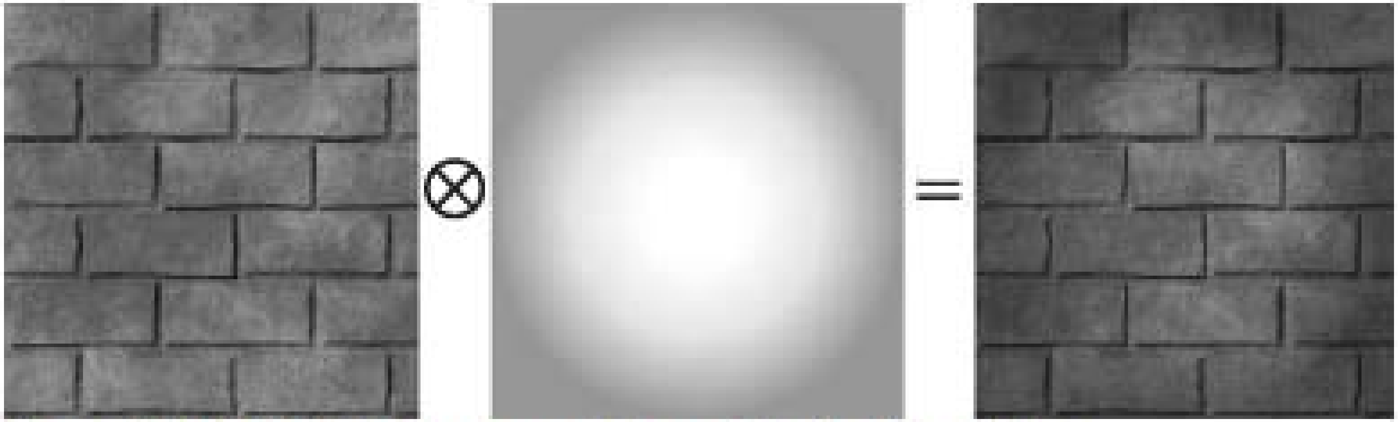


Figure 8.4: Multiplying source color and destination color.

Transparency

$$\mathbf{C} = \mathbf{C}_{src} \otimes \mathbf{F}_{src} \boxplus \mathbf{C}_{dst} \otimes \mathbf{F}_{dst}$$

$$\mathbf{C} = \mathbf{C}_{src} \otimes (a_s, a_s, a_s) + \mathbf{C}_{dst} \otimes (1 - a_s, 1 - a_s, 1 - a_s)$$

$$\mathbf{C} = a_s \mathbf{C}_{src} + (1 - a_s) \mathbf{C}_{dst}$$

For example, suppose $a_s = 0.25$,

$$\mathbf{C} = a_s \mathbf{C}_{src} + (1 - a_s) \mathbf{C}_{dst}$$

$$\mathbf{C} = 0.25 \mathbf{C}_{src} + 0.75 \mathbf{C}_{dst}$$

Usage

- Render function

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

glBindVertexArray(vao);
glDrawElements(GL_TRIANGLES, indices.size(), GL_UNSIGNED_INT, 0);
glBindVertexArray(0);

glDisable(GL_BLEND);
```

Notes

- While loading the texture using SOIL load the alpha channel data as well.
- unsigned char* image = SOIL_load_image(texFileName.c_str(), &width, &height, 0, **SOIL_LOAD_RGBA**);
- glTexImage2D(GL_TEXTURE_2D, 0, **GL_RGBA**, width, height, 0, **GL_RGBA**, GL_UNSIGNED_BYTE, image);

Notes

- The object with the transparency needs to be rendered at the end after rendering all other objects.
- JPEG doesn't support transparency. You'll need to stick to PNG or GIF.
- So the water texture was stored as a PNG for the effect to take place.

Anti Aliasing

Anti Aliasing

- Because the pixels on a monitor are not infinitely small, an arbitrary line cannot be represented perfectly on the computer
- stair-step" (aliasing) effect, which can occur when approximating a line by a matrix of pixels monitor

Anti Aliasing

- Shrinking the pixel sizes by increasing the monitor resolution can alleviate the problem significantly.
- When increasing the monitor resolution is not possible or not enough, we can apply antialiasing techniques.
- Supersampling
- Multisampling

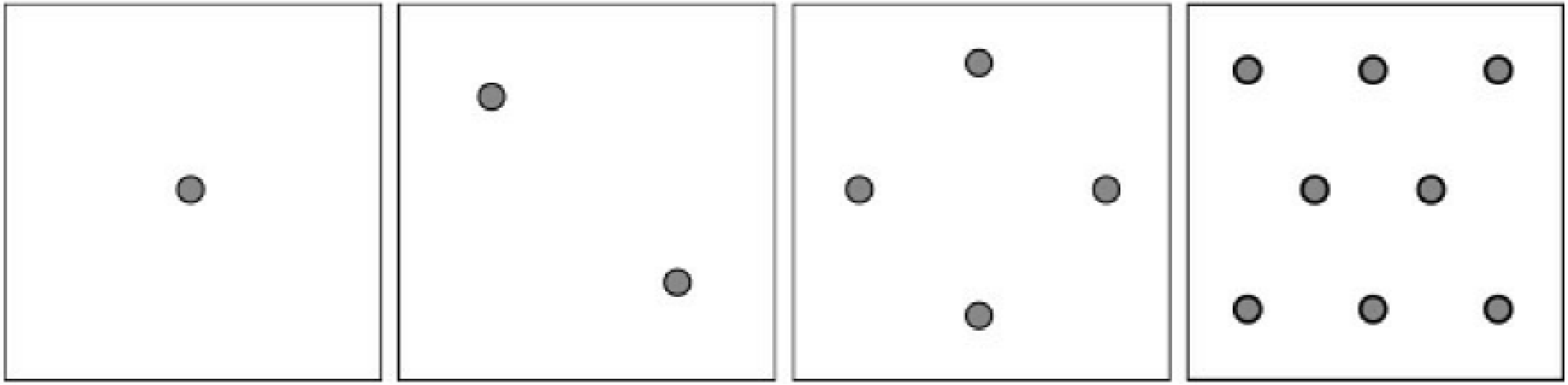
Anti Aliasing

- *supersampling*, works by making the back buffer and depth buffer 4X bigger than the screen resolution.
- The 3D scene is then rendered to the back buffer at this larger resolution
- when it comes time to present the back buffer to the screen, the back buffer is resolved (or downsampled) such that 4 pixel block colors are averaged together to get an averaged pixel color
- Supersampling is **expensive** because it increases the amount of pixel processing and memory by fourfold

Anti Aliasing

- To increase the sample rate of the image, store multiple samples for every pixel on the screen.
- This technique is known as multi-sample antialiasing (MSAA).
- Rather than sampling each primitive only once, OpenGL will sample the primitive at multiple locations within the pixel and, if any are hit, run your shader.

Anti Aliasing



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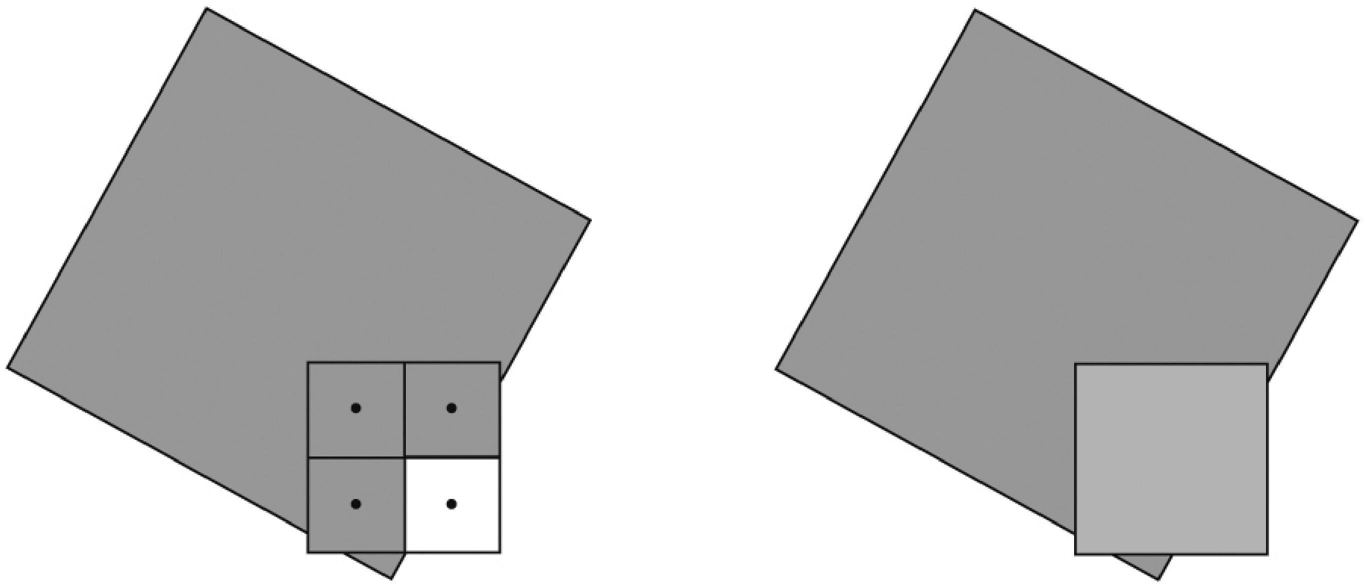
Anti Aliasing



(a) (b)

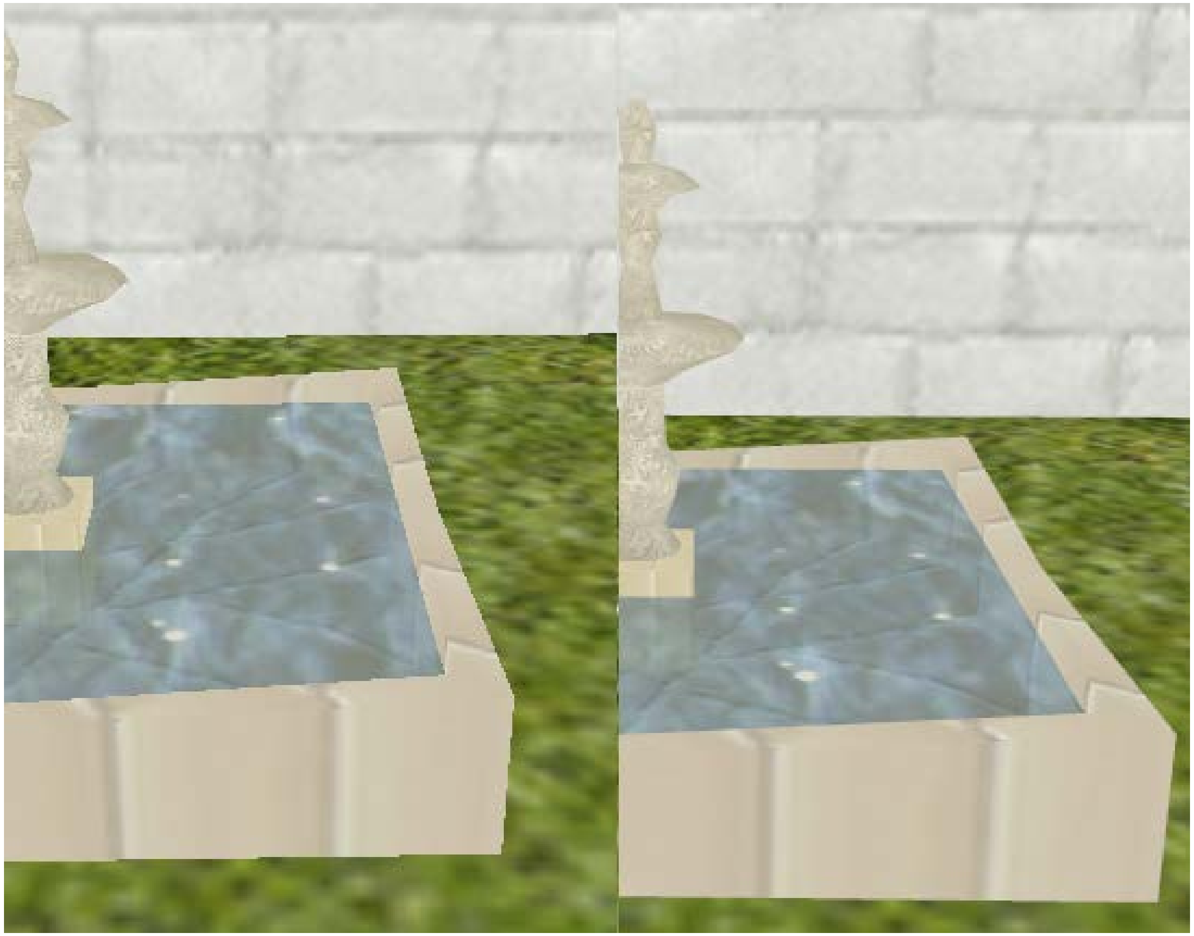
Usage

- In the init function at the start of the game.
- Initalize GLUT parameters in Main
- glutInitDisplayMode(GLUT_DEPTH | GLUT_DOUBLE | GLUT_RGBA| GLUT_MULTISAMPLE);
- Set multisample level

glutSetOption(GLUT_MULTISAMPLE, 8);

glEnable(GL_MULTISAMPLE);

Output



Backface Culling

Backface Culling

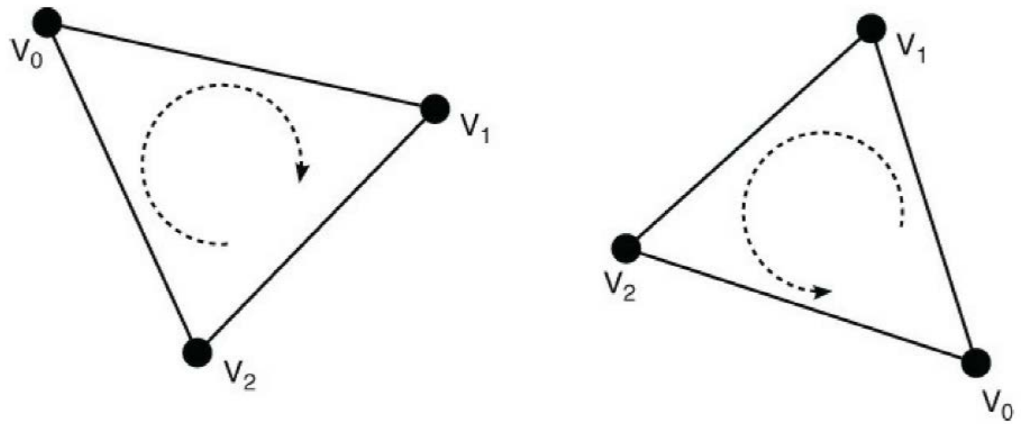
- The elimination of graphics primitives that would not be seen if rendered.
- Back-face culling eliminates the front or back face of a primitive so that the face isn’t drawn.
- Frustum culling eliminates whole objects that would fall outside the viewing frustum.

Backface Culling

- If the triangle faces toward the viewer, then it is considered to be *frontfacing*;
- otherwise, it is said to be *back-facing*
- It is very common to discard triangles that are back-facing because when an object is closed, any back-facing triangle will be hidden by another front-facing triangle.

Backface Culling

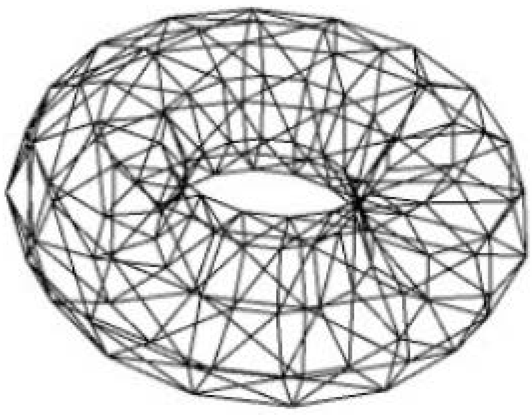
- Winding order determines if the face is front facing or back



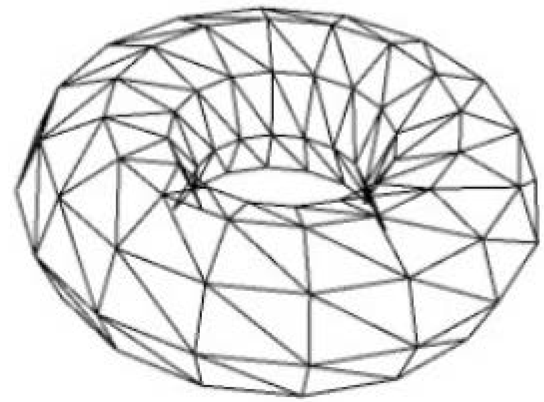
- glFrontFace(GL_CCW);
- Counterclock Wise by DEFAULT

Backface Culling

- Set the back faces to be culled.
- glCullFace(GL_BACK);



Torus drawn in wire-frame
<u>without</u> back face culling



Torus drawn in wire-frame
with back face culling

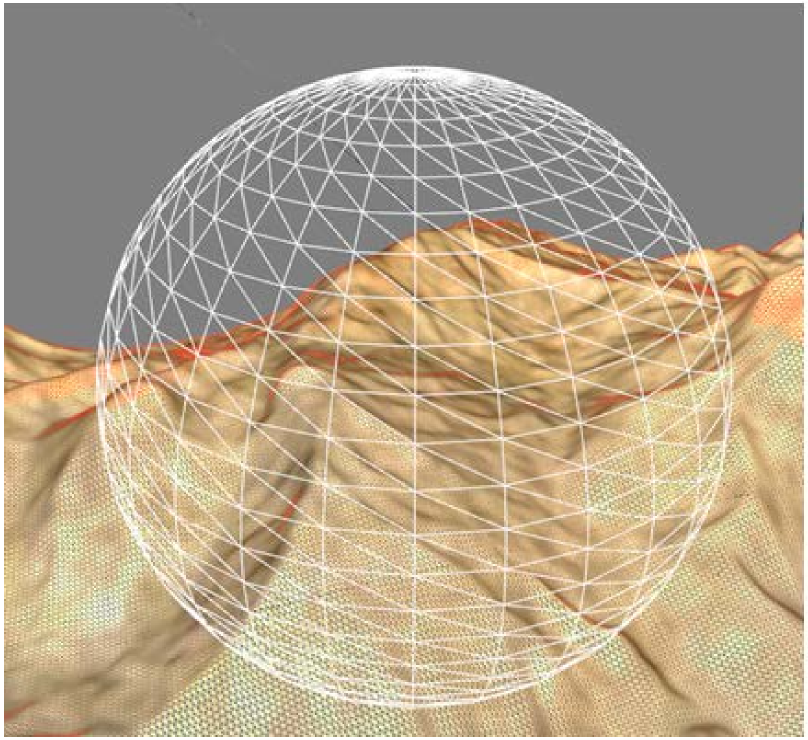
Backface Culling

- Enable face culling
- glEnable(GL_CULL_FACE);

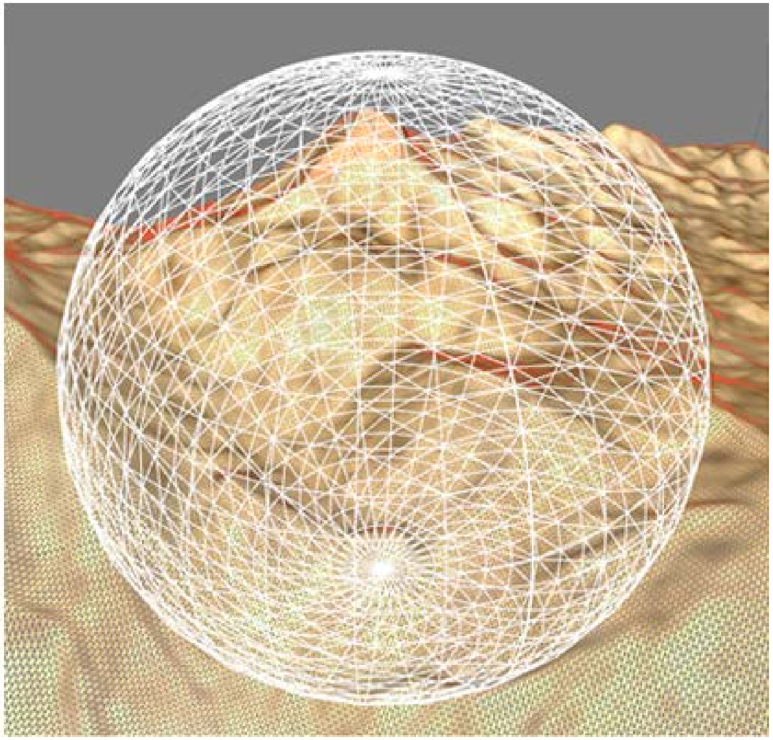
- Example

```
glEnable(GL_CULL_FACE);

glBindVertexArray(vao);
glDrawElements(GL_TRIANGLES, indices.size(), GL_UNSIGNED_INT, 0);
glBindVertexArray(0);

glDisable(GL_CULL_FACE);
```

Output



Enabled



Disabled

Exercises

- Add blending
- Animate the textures water surface
- Enable multisampling
- Enable back face culling for objects