

1. Consider the triangle

$$a = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$b = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$$

$$c = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

For each of the three vertices, determine the point that is twice as close to that vertex than to the other two (in the barycentric sense).

2. Consider the triangle

$$a = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$b = \begin{pmatrix} 1 \\ 2 \\ 0 \end{pmatrix}$$

$$c = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

If a has the color $(132, 75, 0)$, b has the color $(12, 144, 234)$, and c has the color $(252, 99, 198)$, what color does the barycenter of the triangle have using linear interpolation?

3. Calculate the matrix to rotate a 3D vector by 135 degrees around the z axis, and then rotate it by 45 degrees around the x axis. Apply this matrix to the vector

$$\vec{v} = \begin{pmatrix} 0 \\ 0 \\ \sqrt{2} \end{pmatrix}$$

Note:

$$\sin(45) = \cos(45) = \sin(135) = \frac{1}{\sqrt{2}}, \cos(135) = -\frac{1}{\sqrt{2}}$$

4. You are given a triangle with vertices

$$a = \begin{pmatrix} 4 \\ 3 \\ 1 \end{pmatrix}$$

$$b = \begin{pmatrix} 6 \\ 4 \\ -1 \end{pmatrix}$$

$$c = \begin{pmatrix} 3 \\ 3 \\ 3 \end{pmatrix}$$

and normal vector

$$\vec{v} = \begin{pmatrix} \frac{2}{3} \\ -\frac{2}{3} \\ \frac{1}{3} \end{pmatrix}$$

The camera is located at

$$cam = \begin{pmatrix} 7 \\ 1 \\ 3 \end{pmatrix}$$

and looking in direction

$$d = \begin{pmatrix} -2 \\ -2 \\ -1 \end{pmatrix}$$

Does the triangle face the camera?

How far from the plane of the camera is each of the three vertices (hint: The direction vector points in the same direction as the normal of the camera plane)

5. The player is at

$$p = \begin{pmatrix} 1 \\ 2 \\ 1 \end{pmatrix}$$

and looking in direction

$$d = \begin{pmatrix} 2 \\ 1 \\ 2 \end{pmatrix}$$

If they can see anything in front of them (180 degrees field of view), can they see the enemy at e ?

$$e = \begin{pmatrix} 3 \\ -1 \\ -2 \end{pmatrix}$$

How large does their field of view have to be *at least* to be able to see the enemy? 6. Given a triangle with vertices

$$a = \begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix}$$

$$b = \begin{pmatrix} 4 \\ 1 \\ 3 \end{pmatrix}$$

$$c = \begin{pmatrix} -1 \\ -2 \\ 4 \end{pmatrix}$$

Calculate the Barycenter of this triangle. The vertices are assigned the colors

$$\text{color}(a) = (42, 126, 222)$$

$$\text{color}(b) = (124, 204, 54)$$

$$\text{color}(c) = (252, 252, 252)$$

What is the color of the Barycenter?

Which colors do the middle points of the three edges have?

7. Consider the triangle

$$a = \begin{pmatrix} 2 \\ 2 \\ 3 \end{pmatrix}$$

$$b = \begin{pmatrix} 3 \\ 3 \\ 4 \end{pmatrix}$$

$$c = \begin{pmatrix} 3 \\ 1 \\ 3 \end{pmatrix}$$

with the normal vector

$$\vec{n} = \begin{pmatrix} \frac{-1}{\sqrt{6}} \\ \frac{-1}{\sqrt{6}} \\ \frac{2}{\sqrt{6}} \end{pmatrix}$$

and a point

$$p = \begin{pmatrix} 3\sqrt{6} \\ 0 \\ 2\sqrt{6} \end{pmatrix}$$

Does the point p lie in front of or behind the triangle?

8. Consider the triangle

$$a = \begin{pmatrix} 2 \\ 1 \\ 3 \end{pmatrix}$$

$$b = \begin{pmatrix} 4 \\ 3 \\ 4 \end{pmatrix}$$

$$c = \begin{pmatrix} 3.5 \\ 2.5 \\ 4.5 \end{pmatrix}$$

The texture coordinates are

$$t(a) = \left(\frac{3}{5}, \frac{3}{8}\right)$$

$$t(b) = \left(\frac{3}{10}, \frac{3}{16}\right)$$

$$t(c) = \left(\frac{3}{7}, \frac{3}{10}\right)$$

The point p is the closest point to c on the line from a to b . What texture coordinates does p have?