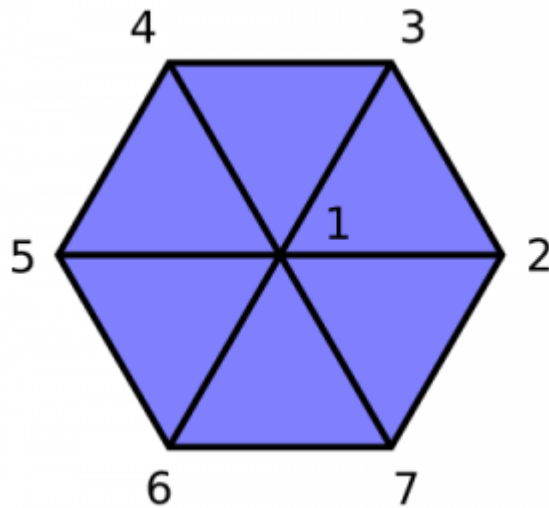## 3D Geometry and Geometric Primitives

1. Draw a picture of a triangulated polygon that can be drawn using a single triangle fan but not a single triangle strip. You must use only the minimum number of vertices. No degenerate triangles can be used.



In a strip, no vertex can appear in more than 3 triangles.

2. Draw a picture of a triangulated polygon that can be drawn using a single triangle strip but not a single triangle fan. You must use only the minimum number of vertices. No degenerate triangles can be used.
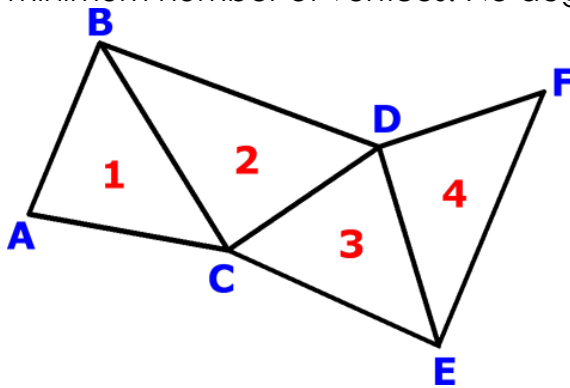


In fan, one vertex appears in all triangles.

3. Suppose a triangle has a normal vector of ⟨1,1,0⟩ and that the vector for the view direction is ⟨1, −2, 0⟩. Is the triangle front-facing or back-facing?

$\langle 1, -2, 0 \rangle \cdot \langle 1,1, 0 \rangle = -1$

Assuming the view vector is expressed as running from the eyepoint to the surface, the triangle is front-facing.

4. The following vertex buffer is suitable for drawing 3 triangles using gl.TRIANGLES and gl.DRAW_ARRAYS. Convert the buffer to one suitable for drawing the same triangles using gl.TRIANGLE_STRIP and gl.DRAW_ARRAYS. Assume we are using a CCW winding order.

| V1 |
|----|
| V2 |
| V3 |
| V3 |
| V4 |
| V1 |
| V4 |
| V3 |
| V5 |

We can express the mesh as a strip with this buffer:

| V5 |
|----|
| V4 |
| V3 |
| V1 |
| V2 |

5. Assume we are using 3D homogenous coordinates. Write down a transformation matrix that first scales by a factor of 3 in X and Z and then translates by 5 in X.

$$\begin{bmatrix} 3 & 0 & 0 & 5 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 3 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

6. Assume we are using 3D homogenous coordinates. Write down a transformation matrix that rotates by 90 degrees about the Y-axis and then 90 degrees about the Z-axis.

$$\begin{bmatrix} 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$