EXERCISES FOR INF3320

TRIANGLE MESHES

1. A tetrahedron is a pyramid where all four faces are triangles.

   (a) What is the Euler-characteristic and the genus?

   (b) Write down an indexed triangle set describing this shape.

   (c) Write down a half edge datastructure describing this shape.

2. A cube is consists of six quadrilaterals.

   (a) What is the Euler-characteristic and the genus?

   (b) Write down an indexed face set describing this shape, by first tessellating into triangles.

   (c) Write down a half edge datastructure describing this shape.

   If we move one of the corners away from the origin, how does our choice of tessellation affect the surface?

   Further, what can we do to improve the shape? Give an outline to an algorithm.

3. Several file formats have been presented in the lecture. Summarize some of the strength and weaknesses of these. Search the web and see if you find more file formats, and find the strength and weaknesses on these as well.

4. A usual measure on the efficiency on a rendering sequence is the number of vertices processed by the number of triangles produced versus the number of vertices processed by the GPU. The GPU has a post transform vertex-cache that holds a few tens of vertices.

   (a) Assume we can specify the entire mesh as a single long triangle strip, in general, what is the efficiency of using this rendering sequence?

   (b) Is there a better way?

5. Mesh decimation usually gives some degradation. In which situation does mesh decimation *not* degrade the mesh?

6. Implement the function `earClipTriangluate` which tessellates polygons with a simple border (both convex and non-convex) into triangles. Base your solution on the following algorithm.

   Given the polygon $P = \{\mathbf{p}_0, \ldots, \mathbf{p}_{N-1}\}$:

(a) If the number of points of P is 3, add this triangle and terminate.

(b) Find a protruding point $\mathbf{p}_i$ in P. Create the triangle $[\mathbf{p}_{i-1}, \mathbf{p}_i, \mathbf{p}_{i+1}]$ and remove $\mathbf{p}_i$ from P.

(c) Go to step (a).

A protruding point is a point $\mathbf{p}_i$ that satisfies:

- The point $\mathbf{p}_i$ is *outside* the half-plane defined by the line $[\mathbf{p}_{i-1}, \mathbf{p}_{i+1}]$.
- All other points are outside all the three halfplanes $[\mathbf{p}_{i-1}, \mathbf{p}_i]$, $[\mathbf{p}_i, \mathbf{p}_{i+1}]$, og $[\mathbf{p}_{i+1}, \mathbf{p}_{i-1}]$ (that is, all points are outside the triangle $[\mathbf{p}_{i-1}, \mathbf{p}_i, \mathbf{p}_{i+1}]$).

To check if $\mathbf{p}$ is inside or outside the halfplane defined by the line $[\mathbf{a}, \mathbf{b}]$, we inspect the orientation (the sign of the signed area) of the triangle $[\mathbf{a}, \mathbf{b}, \mathbf{p}]$.

You can start using `ex6-7_triangulatepoly.cpp.template`.