CMSC 23700	Introduction to Computer Graphics	Homework 4
Winter 2014		Due March 4

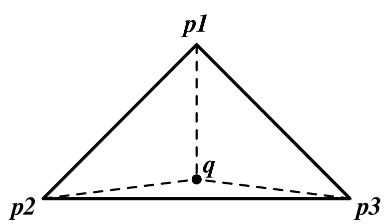
For this homework, you may want to review the "Notes on polygon meshes," which are available from the course web page.

1. Given a direction vector $\mathbf{d}$, we say that an edge e separating two faces, F_l and F_r, with normals $\mathrm{norm(F_l)}$ and $\mathrm{norm(F_r)}$ is a *silhouette edge* if

$$\mathrm{sign}(\mathbf{d} \cdot \mathrm{norm(F_l)}) \neq \mathrm{sign}(\mathbf{d} \cdot \mathrm{norm(F_r)})$$

   A *silhouette loop* is a connected loop of silhouette edges. Give an algorithm for computing the silhouette loop when given a polytope mesh M and $\mathbf{d}$. You should assume the mesh is represented using a winged-edge data structure.

2. One way to make level-of-detail (LOD) transitions is to use an α *fade*, where you lerp the α channel to blend the two LODs. For example, assume that you have a triangle $\triangle\langle\mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3\rangle$ and a vertex $\mathbf{q}$ that splits the triangle into two triangles $\triangle\langle\mathbf{p}_1, \mathbf{p}_2, \mathbf{q}\rangle$ and $\triangle\langle\mathbf{p}_1, \mathbf{q}, \mathbf{p}_3\rangle$ as follows:



   At the coarse LOD, we just render $\triangle\langle\mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3\rangle$, and at the fine LOD, we render both $\triangle\langle\mathbf{p}_1, \mathbf{p}_2, \mathbf{q}\rangle$ and $\triangle\langle\mathbf{p}_1, \mathbf{q}, \mathbf{p}_3\rangle$, but in between we render all three triangles and use alpha blending to smooth the transition.

   Assuming that $0 \leq t \leq 1$, give the blending equation that describes how to combine the two images as a function of t. It should be the case that when $t = 0$, just the coarse LOD is rendered and when $t = 1$, just the fine LOD is rendered.

3. An *axis-aligned bounding box* (AABB) in 2D is defined by four scalar values:

$$\langle minX, maxX, minY, maxY\rangle$$

   We use $\langle 1, -1, 1, -1\rangle$ to denote the empty AABB. Let

$$bb_1 = \langle minX_1, maxX_1, minY_1, maxY_1\rangle$$

   and

$$bb_2 = \langle minX_2, maxX_2, minY_2, maxY_2\rangle$$

   be two *non-empty* AABBs.

(a) What is the minimum AABB that contains the union of bb_1 and bb_2?

(b) What is the minimum AABB that contains the intersection of bb_1 and bb_2?

(c) What is the minimum AABB that contains the difference of bb_1 and bb_2 (*i.e.*, $bb_1 \setminus bb_2$).?