Homework 2: Tessellation of shapes

Due: Tuesday, March 24 (9:30 AM)

Please refer to the handout for description of the size and location of each of the four shapes (in the **Shape Specification** section). When computing surface normals, the results don't have to be unit vectors.

1 Cylinder

Question 1 *The caps of the cylinder are regular polygons with N sides, where N is equal to the first parameter. You will notice in the demo they are cut up like a pizza with N slices each of which is an isoceles triangle. The vertices of the N-gon lie on a perfect circle. Where do these vertices lie, on the top cap and on the bottom cap? (e.g., what are their 3D coordinates?)*

Question 2 *What is the angle at the tip of each isoceles triangle on the cap when the first tessellation parameter is N?*

Question 3 *In solid mode, you can notice that the triangles on the barrel of the cylinder are shaded with a gradient; this is done automatically when you create them with three surface normals, one for each point. What is the surface normal of an arbitrary point* (x, y, z) *on the barrel of the cylinder, whose size/location is described in the handout?*

2 Cone

Question 4 *What is the surface normal of an arbitrary point* (x, y, z) *on the side of the cone, whose size/location is described in the handout?*

3 Sphere

Question 5 *What is the surface normal of an arbitrary point* (x, y, z) *on the side of the sphere, whose size/location is described in the handout?*

4 Cube

Question 6 *Take a look at one face of the cube. In fact, take a look at one edge of one face in wireframe mode. Change the tessellation parameter. How do the number of small squares against one edge correspond to the tessellation parameter?*

Question 7 *You need to tessellate the cube face with triangles. You know that the edges of the cube span from* -0.5 *to* $+0.5$*. Let's make the tessellation parameter = 2. Write down the coordinates of the vertices for the eight triangles which make up the* $y = -0.5$ *plane. (Draw the triangles out and label the vertices with their 3D coordinates).*

Question 8 *What are the normal vectors that correspond to each of these eight triangles?*

Question 9 *A good strategy to use when creating the cube is to first create one side. Once you have the side described above, you can put up the one diametrically opposite by changing just two constants. What are they? (Hint: consider both positions and normals)*

5 Extra credit

Question 10 *For extra fun and extra credit: Can you name all five platonic solids? How about their duals? What does it mean to be a platonic solid? What does dual mean?*

Question 11 *The other method to tessellate the sphere is the geodesic method. How can you use the platonic solids to approximate a sphere? Which solid would give you the best results?*