

Homework 4: Shape intersect

Due: Tuesday, March 31 (9:30 AM)

For this assignment you need to shoot a ray into an object and calculate the intersection points. The general way to solve this problem is representing the ray in a parametric form

$$q = p + td \tag{1}$$

and representing the object in an implicit form

$$f[q] = 0 \tag{2}$$

and solving for the t parameter by substituting Equation (1) into (2).

1 Intersecting objects in general

Question 1 *Given a ray represented by Equation (1) above, what is the t value for the point p on the ray? The t values for the points on the ray in the forward direction of d ? The points “behind” the ray? Draw a line through p in the direction of d and label the values of t for these three sets of points.*

2 Object intersections

In the following questions, you will perform intersection computations **based on x, y, z coordinates**. This amounts to re-write the vector-based ray definition in Equation (1) as

$$(q_x, q_y, q_z) = (p_x, p_y, p_z) + t * (d_x, d_y, d_z) \tag{3}$$

and to re-write the vector based object definition in Equation (2) as

$$f[q_x, q_y, q_z] = 0 \tag{4}$$

and solve for t explicitly using these x, y, z components.

Question 2 *What is the general ray-plane intersection for a plane defined by a point (x_0, y_0, z_0) and a normal (n_x, n_y, n_z) ?*

Question 3 *Write out the sphere-ray intersect equations in terms of t . Use the same dimensions for the sphere that you did in the Shapes assignment (at the origin, radius 0.5) and simplify the equations. Use the definition of the ray in Equation (3).*

Question 4 Write out the cylinder-ray intersect equations in terms of t . Remember, there are three equations: one for the body of the cylinder, and two for each of the caps. Use the same dimensions for the cylinder that you did in shapes ($R = 0.5$ and height $y \in [-0.5, 0.5]$). Use the same ray definition as before.

Question 5 Write out the cone-ray intersect equations in terms of t . Remember, there are two equations: one for the body of the cone, and one for the cap. Use the same dimensions for the cone that you did in shapes. Use the same ray definition as before.