Lecture 15/16/17: Ray Tracing I, II, III – Review Questions

- Mirror reflection, refraction, caustics, and color bleeding are some of the effects that are characteristic of global illumination. Describe these effects and explain why they do not fit well into the graphics pipeline as we have seen it so far in class. What are some other effects that require global illumination algorithms?
- The standard Graphics pipeline includes a projective transformation. Why is this not the case for ray tracing?
- Ray tracing simulates a pin-hole camera. What does that mean?
- What is the difference between ray casting and ray tracing? What effects can ray tracing pick up that ray casting cannot?
- Give an algorithm for ray casting. For all pixels…
- What is the difference between forward and backward ray tracing? Which technique do we focus on in the 3rd programming assignment? Why is this technique more practical?
- In earlier classes, we saw the following equation for Phong Illumination:

  $$I = k_a L_a + k_d (l \bullet n) L_d + k_s (r \bullet v)^{\alpha} L_s$$

  Ray tracing adds two more terms to this equation: $k_r I_r + k_t I_t$

  Explain the parameters in these two terms and describe how I_r and I_t are calculated.
- Which part of the equation above is the direct lighting calculation?
- What is a shadow ray? How is it used in the direct lighting calculation?
- Give an algorithm for ray tracing. For all pixels…
- Derive an expression for the reflection ray in terms of the surface normal and the incoming direction.
- Give Snell's Law and use it to derive an expression for the refraction ray in terms of the surface normal, the incoming direction, and the indices of refraction of the two media.
- What is total internal reflection? How do we identify this situation?
- In ray tracing we choose to trace very few rays through the scene in order to keep computation times reasonable. List some of the paths that light can travel that are not captured by ray tracing.
- Consider again the following effects: mirror reflection, refraction, caustics, and color bleeding. Which of these can be captured through ray tracing? For which does ray tracing not perform well?

- Derive the expression for ray-sphere intersection, and consider all cases: zero, one, or two intersection points.
- Show how to compute ray triangle intersections, including identification of barycentric coordinates for use in interpolation of normals and texture coordinates.
- What is instancing? Give two benefits of using instancing for ray tracing.
- Consider a partially transparent object that is illuminated with two lights, one visible from each side of the object. Start with a ray from the eye that hits one side of this object at approximately a 45 degree angle from the surface normal and sketch all of the rays that will be traced to determine the color of that intersection point.
- Distributed ray tracing can be used to capture a variety of effects and create less sharp and more realistic images. Explain how to use distributed ray tracing to capture each of the following effects:
    - antialiasing
    - gloss
    - translucency
    - soft shadows
    - depth of field
    - motion blur
- What is jittering? Contrast this technique to regular sampling and random sampling. Why is it useful?
- If we use distributed ray tracing for all of these effects at once, how can we keep the number of rays that are traced in a scene to some reasonable number and still get good even sampling of each of these effects?