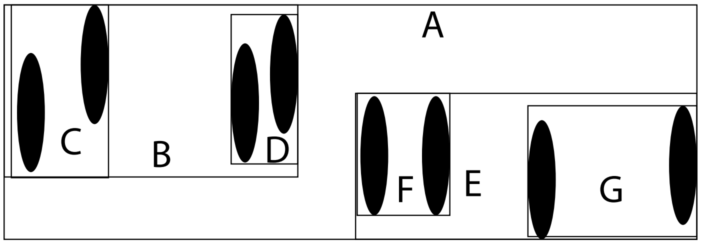
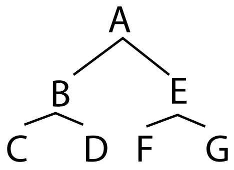
# Stanford CS248: Interactive Computer Graphics
# Participation Exercise 5

## Problem 1: Miscellaneous Short Problems

A. Consider the scene and corresponding bounding volume hierarchy (BVH) shown below. The BVH has two objects in each leaf. Consider an implementation of ray-scene intersection using this bounding volume hierarchy (BVH). In this implementation, the ray **always attempts to first descend into the left child of the current node**. Draw a ray on the figure that intersects all objects, but for which computing the closest ray-scene intersection using the BVH would **NOT PROVIDE ANY SPEEDUP** vs. iterating over all objects in the scene. Label this ray R1. Then draw a ray (please label it R2) for which the results of ray-scene intersection can be determined completely using only three ray-bounding box checks (and no ray-object checks).

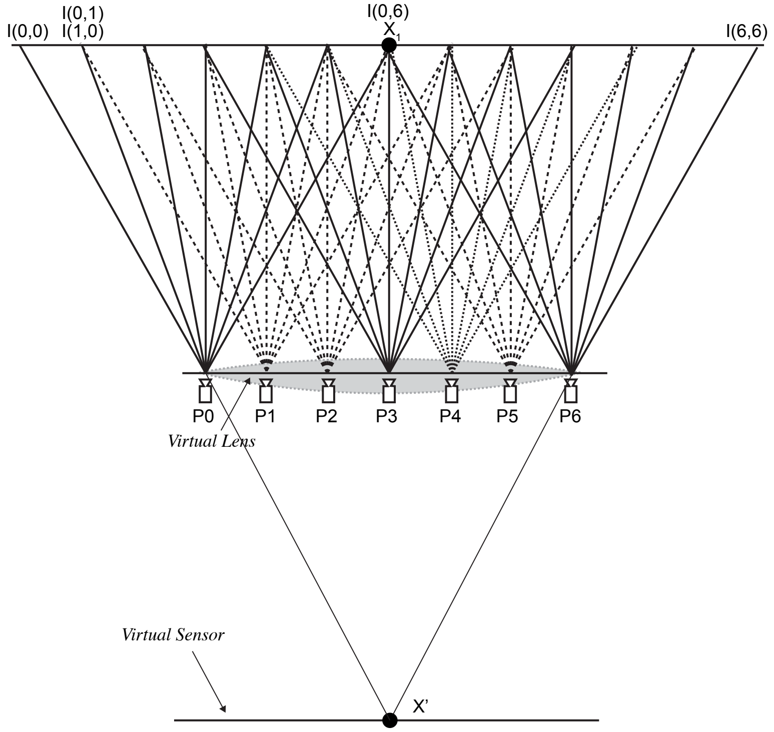




B. A diffuse surface scatters light equally in all directions. In more technical terms, its BRDF $f(\omega_i, \omega_o)$ is constant. But clearly different parts of a diffuse surface are brighter than others, just look at the image in slide 6 (or the left image in slide 44) of Lecture 10. Briefly explain why this is the case. (Hint... the BRDF described the fraction of light from an input direction *per unit area* that is scattered in a certain direction.)

**Problem 2: Simulating a Really Big Camera**

Seven students stand in a straight line at positions $P0 - P6$, and take pictures of the opposite wall of the room with pinhole cameras as shown in the figure. Assume that each camera is a 7-pixel camera, and that the value of pixel $j$ in the image acquired by camera $i$ is written as $I(i, j)$. (For simplicity, let's assume our cameras take 1D images.)



A. Now imagine that the seven students take their seven pinhole camera photographs and use the pixels $I(i, j)$ from these photographs to *simulate what image would have been made by a VIRTUAL CAMERA with an enormous lens spanning the spacing of all the students! (the gray shaded region in the figure.)* Recall from the VR lecture in class that when a camera with a lens is focused at a certain depth in the world, all rays of light from world points on this plane that pass through the lens aperture converge to the same point on the sensor. For example, all rays of light from point $X_1$ through the virtual lens should converge at point $X'$ on the sensor. If you wanted to compute the value of the virtual camera's pixel at $X'$ what pixels $I(i, j)$ should you add up? (Observe that we are approximating the image formed by a large aperture lens using seven samples from pinhole cameras positioned on the virtual lens!)

B. Now consider simulating the behavior of this virtual camera when it is NOT FOCUSED on the wall, but instead focused at the closer point $X_2$ (it is marked on the figure below). Describe (words is fine) how you might go about computing the the color of virtual camera's pixel X′ in terms of the I(i,j)'s. Hint 1: the red lines in the figure might help you visualize where rays originating from $X_2$ in the world land on the virtual sensor. Hint 2: the word interpolate might be useful to you.