CPSC 478/578 Computer Graphics
Fall 2015
Assignment #3
Assigned: Wednesday, September 23, 2015
Due: Wednesday, Oct 7, 2015, 11:55pm

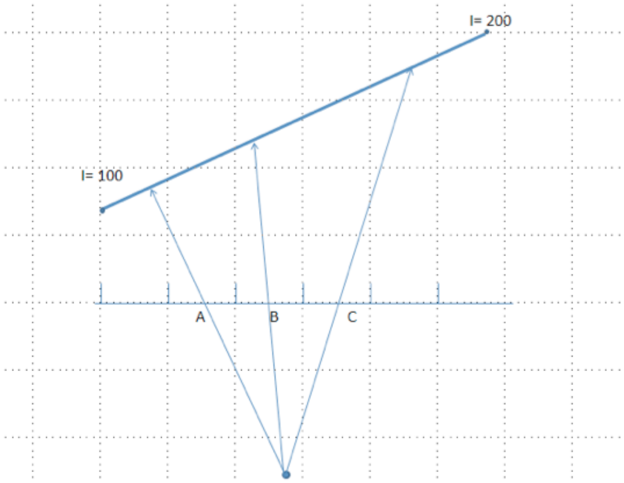
Note that the requirements for each question may vary depending on whether you are registered for 478 or for 578. The area addressed in this assignment is computing visibility at each pixel in an image.

Turn-in Procedure

You should submit your work as a zip file using the classesv2 server. Please name your file as LastNameFirstName-Assignment3.zip
When your file is unzipped there should be subdirectories for each question named q1, q2, etc. Name your files as directed in each question. In each directory you should have:

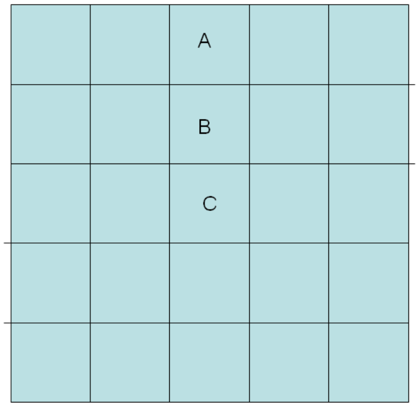
1. The HTML and Javascript programs you have written, or pdf's of your written response (either typed directly or scanned in). For code, you should use files in the form of the samples given, rather than producing files from scratch. This will help us follow your code.
2. If the question asks you to write code to make images, provide sample images created by your program. You can save these by clicking and saving results in your browser, or by taking a screenshot.
3. A readme.{txt, doc} that lists the input used to create the images you include. You should also list the operating system (e.g. Linux, Windows 7, 8.1, 10, Mac OS 10.4.4) and browser (e.g. Firefox 40.0.2, Safari, IExplorer, Edge) that you used. If you programs fail on the machines used for grading, you may be asked to bring in your system to demonstrate that the files you submitted functioned in the environment you worked in.

Question 1 (**478 and 578**). No coding required, scan or type in your response and provide as a pdf.
a.) Consider the rendering shown below. A line segment has intensities of 100 and 200 at its two ends, and the intensity on the segment varies linearly between the end values. What is the error in estimating the intensity of pixel B by interpolating between the intensities computed for pixels A and C?



b.) Consider a virtual camera in a world coordinate system with the eye point at

(1,10,2) and looking in the direction towards point (2, 10, -4), with an up direction given by the unit vector (0,1,0). The virtual camera has a view frustum that is 45 degrees both horizontally and vertically. A 5 by 5 pixel image is to be computed.
i. Give an equation in terms of a parameter t for all points P that lie on the ray from the camera origin through the center of the center pixel (pixel C in the diagram below) of the image.
ii. Find the angle between the rays that go through the centers of pixel A and pixel B. Is the angle between the rays that go through the centers of pixel B and pixel C the same, larger or smaller. Justify your answer.



Question 2 (478 and 578) Create a Javascript program that generates a 512 by 512 image. The image will be an orthographic projection of a shaded sphere. The eye will be at the point (0,0, infinity), and the image coordinates are from (-1,-1) on the lower left to (1, 1) on the upper right. The program should take as input a sphere diameter. A sphere diameter of one should occupy the full image (i.e. should have a diameter of 512 pixels.) The center pixel should be the point on the sphere with the normal pointing at the viewer. The program should also take as input a RGB values that give the maximum color value of a pixel on the sphere, and a vector giving the direction of the incident directional light. The program should produce an image of the sphere illuminated. Turn in two sample images, with different colors and light directions Do not use any WebGL calls for question. Provide two sample images from your program, with different sizes, colors and light direction.

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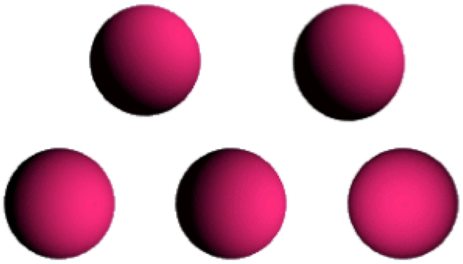
Here are some examples of spheres lit from different directions:



Question 3 Casting rays -- antialiasing
Use the code from the literate raytracer pages (zip file available in Resources) as a starting point for this question. Do not use any WebGL calls.
(478 and 578) Using index.js as a starting point, create index_aa.js that uses the average of the colors computed for 4 rays cast through 4 different points in each pixel are averaged to compute the pixel color. Submit a sample image produced by your code.
(578) Write another version of the code index_aa_adaptives.js that continues to cast additional sets of 4 rays through the pixel until value of the computed pixel color does not change. Submit a sample image produced by your code.

Question 4 Casting rays -- Object types.
Do not use any WebGL calls for this question.
(478 and 578) Using index.js as a starting point, create index_tri.js so that there is an additional object type "triangle" with attributes point1, point2 and point3 to define where it is, e.g. an entry might be:

```
{
      type: 'triangle',
      point1: {
         x: -4,
         y: 2,
         z: -1
      },
      point2: {
         x: 4,
         y: 2,
         z: -1
      }
      point3: {
          x: 4,
          y:  4,
          z: -1
      }
      color: {
         x: 155,
         y: 155,
         z: 155
      },
      specular: 0.1,
      lambert: 0.9,
      ambient: 0.0,
},
```

You will need to write code to find the intersection point and normal for this object type. Submit an image rendered with at least two visible triangles in the scene.

(578) Using index.js as a starting point, create index_tri_cone.js that includes both triangle and cone object types. The cone attributes should be the center, the height and radius of the cone object. You may assume that the main axis of the cone is parallel to the y axis. Submit an image rendered with at least one cone visible in the image.