CPSC 478/578
HW #5
Due November, 2, 2015, 11:55pm

Note that the requirements for each question may vary depending on whether you are registered for 478 or for 578. The areas addressed in this assignment are implicit geometries and color.

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, as well as answering any questions posed in the problem. 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.

READ Chapter 28 of Hughes et al. as well as the lecture notes for doing this problem set. Each problem is work 20 points.

1. **(478 and 578)** Write code similar to what you wrote to display the orthogonal view of the sphere displayed in question 2 of problem set 3. Instead of displaying a sphere, display a superellipsoid that fills the 512 x 512. A superellipsoid is defined by the following implicit equation:

$$\left(x^q + y^q\right)^{t/q} + z^t - 1 = 0$$

This superellipsoid should have a radius of 1, so that does not need to be a parameter supplied by the user. The user should supply values of q and t that will determine how puffy or pointy the shape is. When q=t=2 the result should be the sphere image from problem set 3. Use a value of $\Delta x = \Delta y = \Delta z = 0.01$ in the approximation of the gradient to compute the normal for determining the shading of the superellipsoid. You can see some images of superellipsoids at:
http://regular-polygon.com/plugins/superellipsoid/
http://www.f-lohmueller.de/pov_tut/all_shapes/shapes350e.htm

2. **(478 and 578)** Write code to create a 512x512 pixel image of a cloud modeled as a soft object defined by defined by three centers (x_i, y_i) and radii R_i and the function C(x,y) where

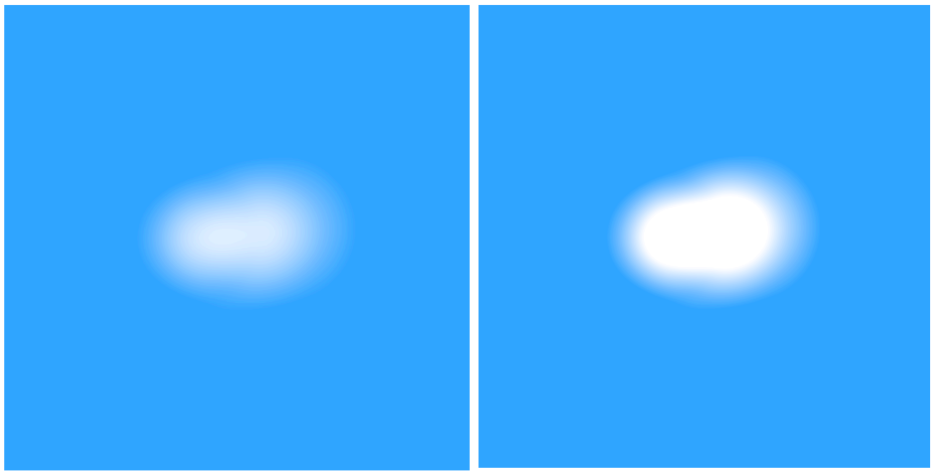
$$r_i^2 = (x - x_i)^2 + (y - y_i)^2$$

$$F_i(x,y) = (-\frac{4r_i^6}{9R_i^6} + \frac{17r_i^4}{9R_i^4} - \frac{22r_i^2}{9R^2{}_i} + 1), \quad \frac{r_i^2}{R_i^2} <= 1$$

$$F_i(x,y) = 0, \frac{r_i^2}{R_i^2} > 1$$

$$C(x,y) = \max[(\sum_i F_i(x,y) - 0.1), 0]$$

The user should be asked to enter the coordinates of the three centers and radii, with an explanation of the units (i.e. in pixels or will everything be scaled 0 to 1.). Render the background as RGB=(50,150,255), a sky color, and the densest possible soft object area as (255,255,255) to get an image such as (but not necessarily exactly the same as) that shown on the left. That is, interpolate between the sky color and "cloud" color based on the value of the function C(x,y). To get a cloud-like effect, you will need to consider how to scale the values to avoid get flat white areas such as in the image shown on the right. In your "readme" file for this problem, along with giving the parameters for your sample images, explain how you interpolated the colors.

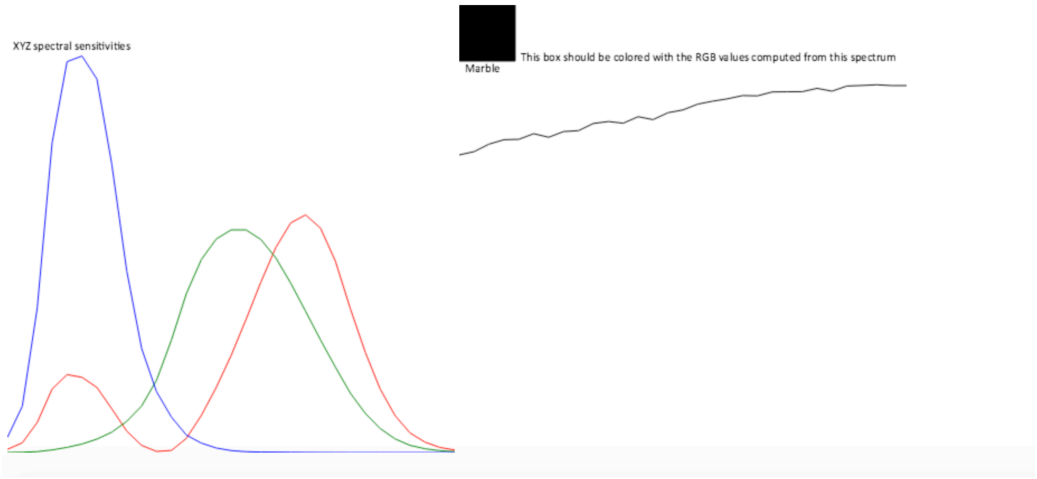


3. **(478 and 578)** Using the color.html file provided, compute *relative* X, Y and Z values of the materials Pine, Flower, Marble, Grass and Jeans. Include the values you compute in your readme file for this question. Compute the values of R, G, and B for these materials and display them, assuming that it is valid to use the equation for sRGB given as Hughes et al. Eq. 28.43.In order to scale the values to 0 to 255, use the scaling values necessary for the given white spectrum to be mapped to R=G=B=255.

Colors from Spectra

Select a spectrum to convert to a color

Black | White | Flower | Pine | Grass | Jeans | Marble



4. **(478 and 578)** NO PROGRAMMING FOR THIS QUESTION
a. Hughes et al., Problem 28.1, p. 780
b. Hughes et al., Problem 28.2, p. 780
c. **(578 only)** Hughes et al., Problem 28.7, p. 781

5. (478 and 578) Write a paragraph or two (i.e. about half a page of text) describing an idea for your final project, a game. The game should be based on the Envy My Car code, but should be a totally different game. Your game can have the same type of interaction as Envy My Car (starting and turning using the mouse and keyboard input). It should have a different geometry though from Envy My Car. You should design a new simple 3D scene, and new objects or characters. Your game should have two particularly challenging aspects (three for **578** students). Challenging aspects include (but are not restricted to) a complex character that has appendages (i.e. arms and/or legs) that move relative to the character as the character moves, a group of objects or characters that move along pre-computed spline paths during the game, collision detection, novel textures and/or lighting effects.

If you have a data visualization or ray-tracing project that you want to do instead of the game design, describe the project you have in mind. Explain how it will use methods we have gone over in this course.