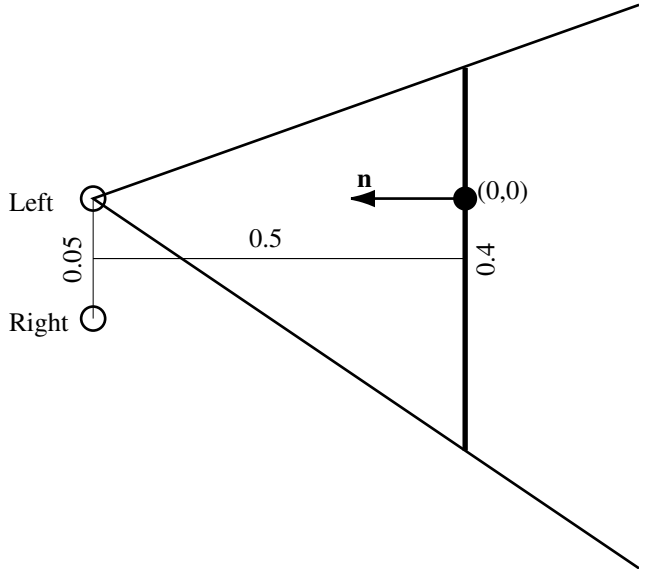
CS 559: Computer Graphics

Homework 4 Solutions

Question 1:

This question explores the perspective projection setup for stereo viewing. The situation is shown in the figure below. A user is wearing shutter-glasses, which are glasses that rapidly flicker in time to the monitor's refresh rate. The viewer sees one image with their left eye, then one with their right, and so on. The viewer's eyes are 0.05 units apart, and they are staring into infinity through a monitor that is 0.5 units away from them and 0.4 units wide. The monitor is centered so that a line passing through the midpoint between the viewer's eyes, in the direction they are looking, will pass through the center of the monitor and be perpendicular to it.



Consider the image that will be shown to the left eye. The image plane in view space is the plane of the monitor. The $(x, y) = (0, 0)$ point in the image plane in view space is shown on the figure, as is the view plane normal and the view frustum for this case.

a. What is an appropriate value to specify the near clipping plane? *[1 point]*

   One good value to choose is 0.5, which means that nothing that is between the viewer and the monitor in virtual space will be rendered.

b. What value would you use to specify the left clipping plane? *[1 point]*

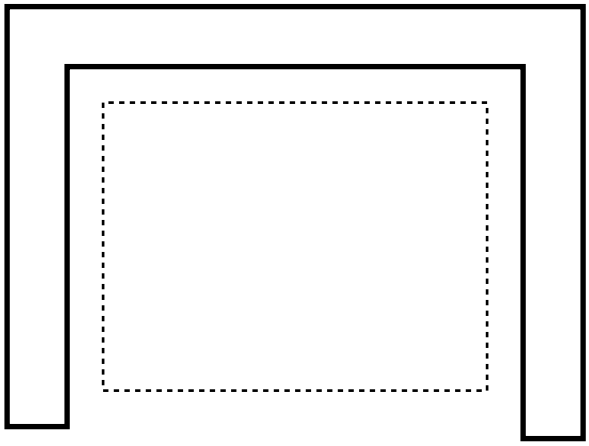
   If you chose 0.5 for part (a), the you need 0.175 as the left clipping plane. That is the place where the left clip plane intersects the near clip plane.

c. What value would you use to specify the right clipping plane? *[1 point]*

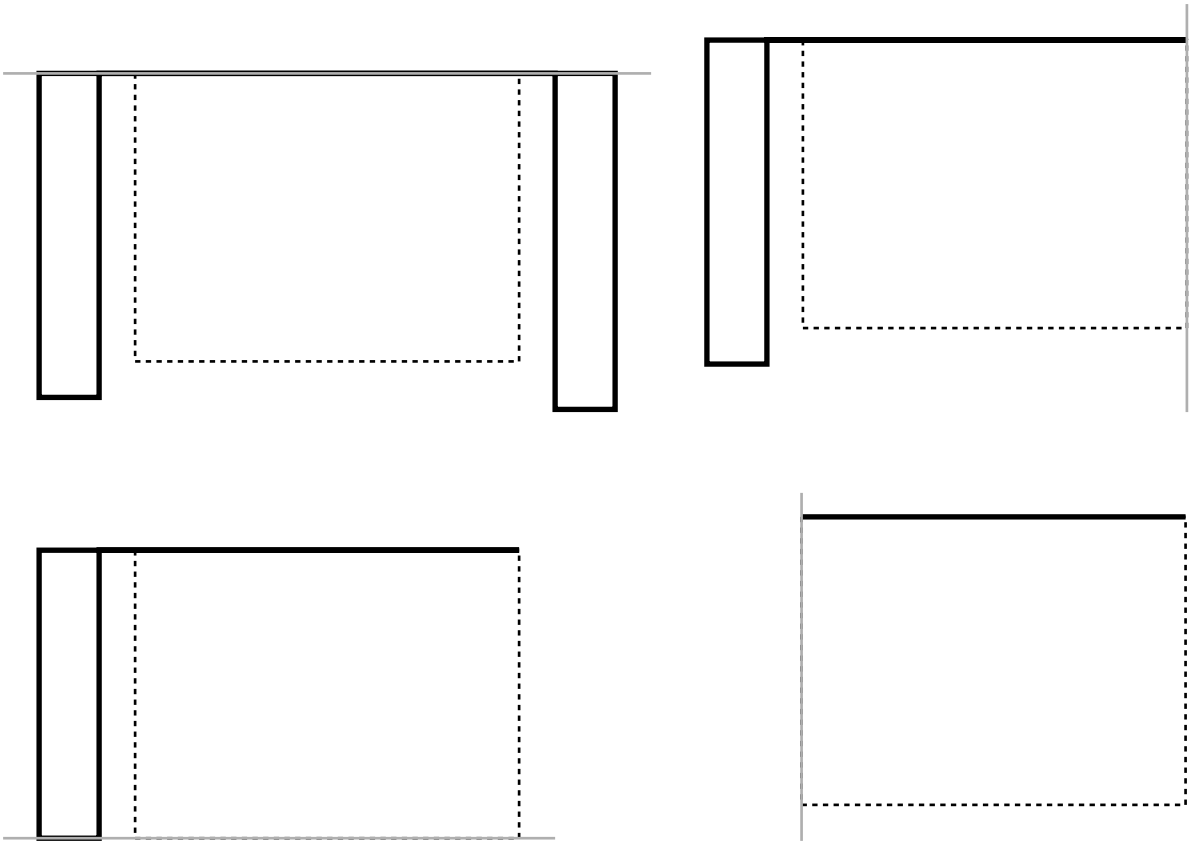
   If you chose 0.5 for part (a), the you need 0.225 as the right clipping plane.

Question 2:

Perform Sutherland Hodgman clipping on the figure below to the rectangular clip region shown dashed. Show the intermediate results after clipping with the top edge, the results after clipping with the top and right edges, the results after the top, right and bottom edges, and the final results. (You should show 4 figures in all.) *[8 points]*

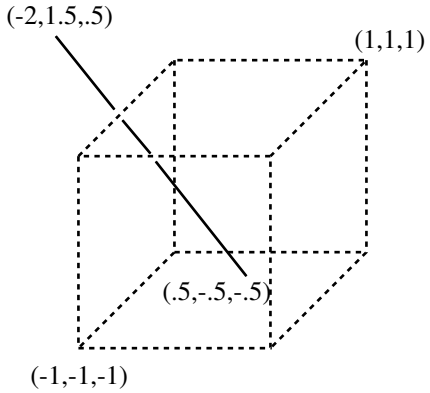


Note that a zero-area polygon remains across the top edge of the clip region.



Question 3:

This question explores Liang-Barsky clipping for the canonical 3D view volume. Consider the line segment and clip region shown below.



a. What is the parametric equation of the line? *[3 points]*

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -2 \\ 1.5 \\ 0.5 \end{bmatrix} + t \begin{bmatrix} 2.5 \\ -2 \\ -1 \end{bmatrix}$$

or, if you want the line to go the other way:

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0.5 \\ -0.5 \\ -0.5 \end{bmatrix} + t \begin{bmatrix} -2.5 \\ 2 \\ 1 \end{bmatrix}$$

b. What are the six parametric coordinates (the t values) for the intersections of the line with each clip plane? Label them as entering or leaving intersections. *[6 points]*

Plane	t	Status
Left	0.4	*Entering*
Right	1.2	*Leaving*
Top	0.25	*Entering*
Bottom	1.25	*Leaving*
Near	1.5	*Leaving*
Far	-0.5	*Entering*

The alternate form of the line will give parameter values $t' = 1 - t$ and will reverse all the entering/leaving labels.

c. What are the parametric coordinates of the end-points of the visible segment? *[4 points]*

For the first formulation, the endpoints are $t_{start} = \max(0, enterings) = 0.4$ and $t_{end} = \min(1, leavings) = 1$. For the alternate line formulation: $t_{start} = 0.0$ and $t_{end} = 0.6$.

d. What are the (x, y, z) coordinates of the end-points of the visible segment? *[2 points]*

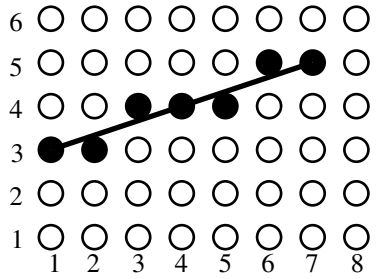
Putting the values of t_{start} and t_{end} back into the equations gives (-1, 0.7, 0.1) and (0.5, -0.5, -0.5).

Question 4:

Fill out a table with the per-pixel values for x_i, y_i and p_i when Bresenham's algorithm is applied to the line from (1,3) to (7,5). There will be seven sets of values. *[7 points*]

To begin with, compute $\Delta x = 6$ *and* $\Delta y = 2$.

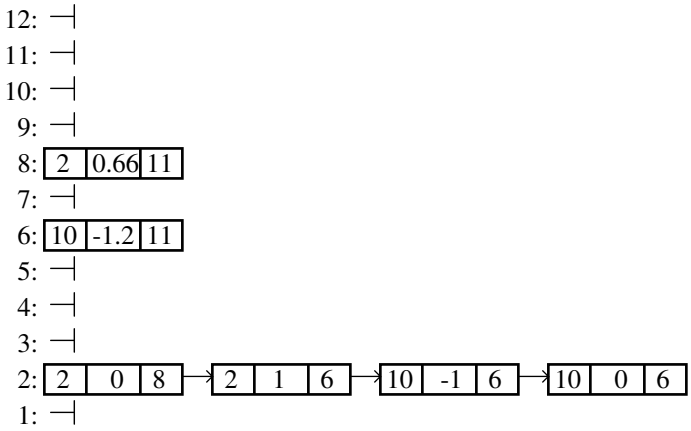
x	y	d
1	3	-2
2	3	2
3	4	-6
4	4	-2
5	4	2
6	5	-6
7	5	-2



Question 5:

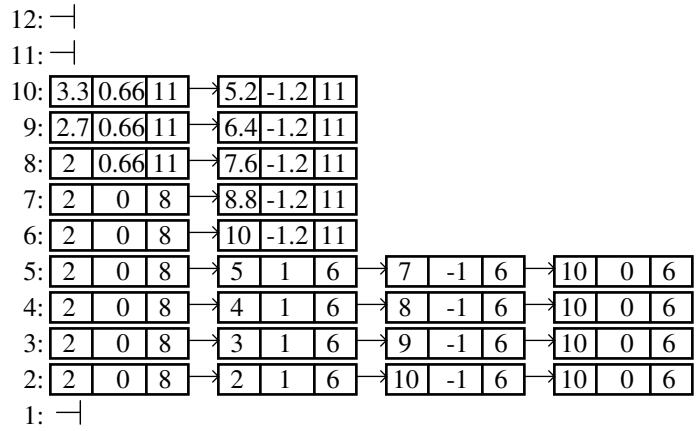
Consider the task of filling of the polygon shown:

Edge Table:

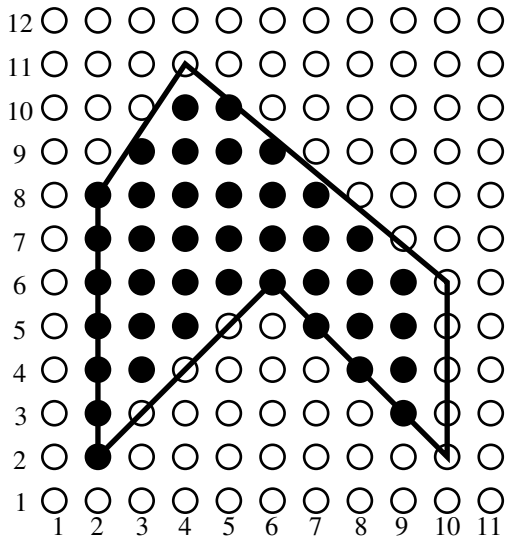


[6 points]

Active Edge List



[6 points]



[4 points]