Lab12 for CPT205 Computer Graphics (Hidden Surface Removal)

Part I. Hidden Surface Removal

1) Compare and differentiate between clipping and hidden surface removal.

2) What are object-space and image space approaches to hidden-surface removal?

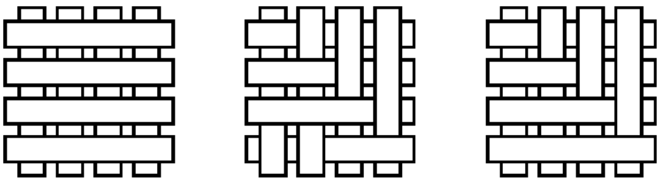
3) Discuss each of the following methods for hidden surface removal with figures where necessary.

(a) Back-face culling
(b) Painter's method
(c) BSP
(d) Z-buffer

4) BSP trees can be used in hidden surface removal.

(a) Describe how BSP trees are used in hidden surface removal.
(b) BSP trees are not unique for the same set of polygons; discuss this with an example.

5) The drawings below are in image space where each rectangle is a single primitive. Which of the three cases would have problems when the Painter's algorithm is applied to rendering the image and why?

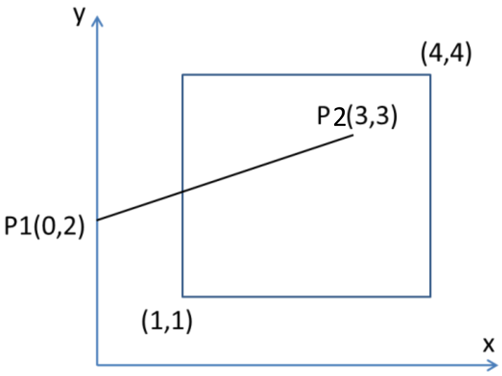


(a) (b) (c)

PART II. Sample answers to PART I for Lab11

1) Cohen-Sutherland 2D Line Clipping

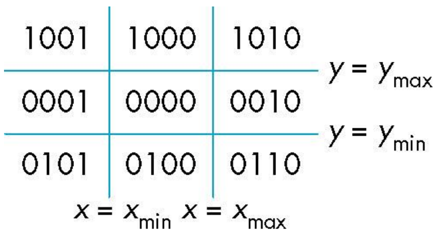
Given a clipping window defined by points (1,1) and (4,4), and a line defined by P1(0,2) and P2(3,3), clip the line using the Cohen-Sutherland 2D line clipping algorithm. You are required to perform the following tasks:



a) Decide the outcodes for the 9 regions of the clipping window plane
b) Decide the outcode for each of the two end points of the line
c) Provide the main steps of your working
d) Show the final results for rendering the line after clipping

Sample Answer

a)



b) outcode(P1) = 0001
outcode(P2) = 0000

c) (i) We know
P1(0,2), P2(3,3), wy_top = 4, wy_bottom = 1, wx_right = 4, wx_left = 1;
outcode(P1) = 0001, outcode(P2) = 0000.

(ii) outcode(P1) | outcode(P2) ≠ 0, so not trivial accept;
outcode(P1) & outcode(P2) = 0, so not trivial reject.

(iii) Because the bit for wx_left in outcode(P1) is 1, we need to find the intersection point between the line and left clipping window edge wx_left = 1

using wx_left = 1 for equation y = mx+b = (1/3)*x+2
we have the intersection point S1(1,2.33), and outcode(S1) = 0000

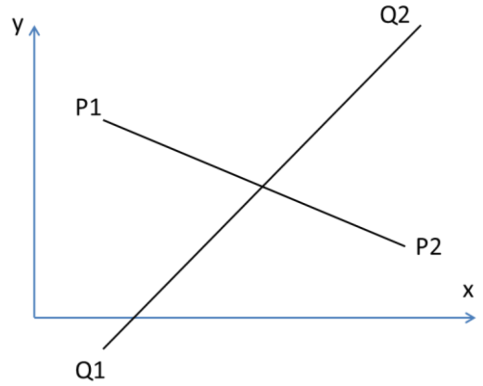
We therefore replace P1(0,2) with S1, and
delete line segment P1-S1 and output S1-P2 for rendering.

d) The final output is S1(1,2.33)-P2(3,3).

2) Parametric Lines

For two line segments in a plane, represented in parametric form:

$\mathbf{p}(\alpha)=(1-\alpha)\mathbf{p}1+\alpha\mathbf{p}2$
$\mathbf{q}(\beta)=(1-\beta)\mathbf{q}1+\beta\mathbf{q}2$



a) propose a procedure for determining whether the segments intersect and,
b) if so, propose a procedure for finding the point of intersection.

Sample Answer

We are looking for an α and β such that both parametric equations yield the same point, that is

$x(\alpha) = (1-\alpha)x_{p1} + \alpha x_{p2} = (1-\beta)x_{q1} + \beta x_{q2}$
$y(\alpha) = (1-\alpha)y_{p1} + \alpha y_{p2} = (1-\beta)y_{q1} + \beta y_{q2}$

These are two equations for the two unknowns α and β, and as long as the line segments are not parallel (a condition that will lead to a division by zero), we can solve values for α and β. If both values are between 0 and 1, the segments intersect.