Lecture 16 (DLP)

Unit 2

# Liang Barsky Line clipping Algorithm

- Based on analysis of parametric equation of a line segment, faster line clippers have been developed, which can be written in the form .

$$x = x_1 + u\,\Delta x$$
$$y = y_1 + u\,\Delta y \qquad\qquad 0 <= u <= 1$$

where $\Delta x = (x_2 - x_1)$ and $\Delta y = (y_2 - y_1)$

- In the Liang-Barsky approach we first write the point clipping condition in parametric form :

$$xw_{min} <= x_1 + u\ \Delta x <=.\ xw_{max}$$

$$yw_{min} <= y_1 + u\ \Delta y <= yw_{max}$$

- Each of these four inequalities can be expressed as :

$$\mu p_k <= q_k. \qquad k=1,2,3,4$$

- i.e

$$p_1 = -\Delta x \qquad q_1 = x_1 - xw_{min}$$
$$p_2 = \Delta x \qquad q_2 = xw_{max} - x_1$$
$$P_3 = -\Delta y \qquad q_3 = y_1 - yw_{min}$$
$$P_4 = \Delta y \qquad q_4 = yw_{max} - y_1$$

- Any line that is parallel to one of the clipping boundaries have pk=0 for values of k corresponding to boundary k=1,2,3,4 correspond to left, right, bottom and top boundaries. For values of k, find qk<0, the line is completely out side the boundary.

- If qk >=0, the line is inside the parallel clipping boundary.

- When pk<0 the infinite extension of line proceeds from outside to inside of the infinite extension of this clipping boundary.

- If pk>0, the line proceeds from inside to outside, for non zero value of pk calculate the value of u, that corresponds to the point where the infinitely extended line intersect the extension of boundary k as :u = qk / pk

- For each line, calculate values for parameters u1and u2 that define the part of line that lies within the clip rectangle. The value of u1 is determined by looking at the rectangle edges for which the line proceeds from outside to the inside ($p<0$).
- For these edges we calculate :

$$r_k = qk / pk$$

- The value of u1 is taken as largest of set consisting of 0 and various values of r. The value of u2 is determined by examining the boundaries for which lines proceeds from inside to outside ($P>0$).

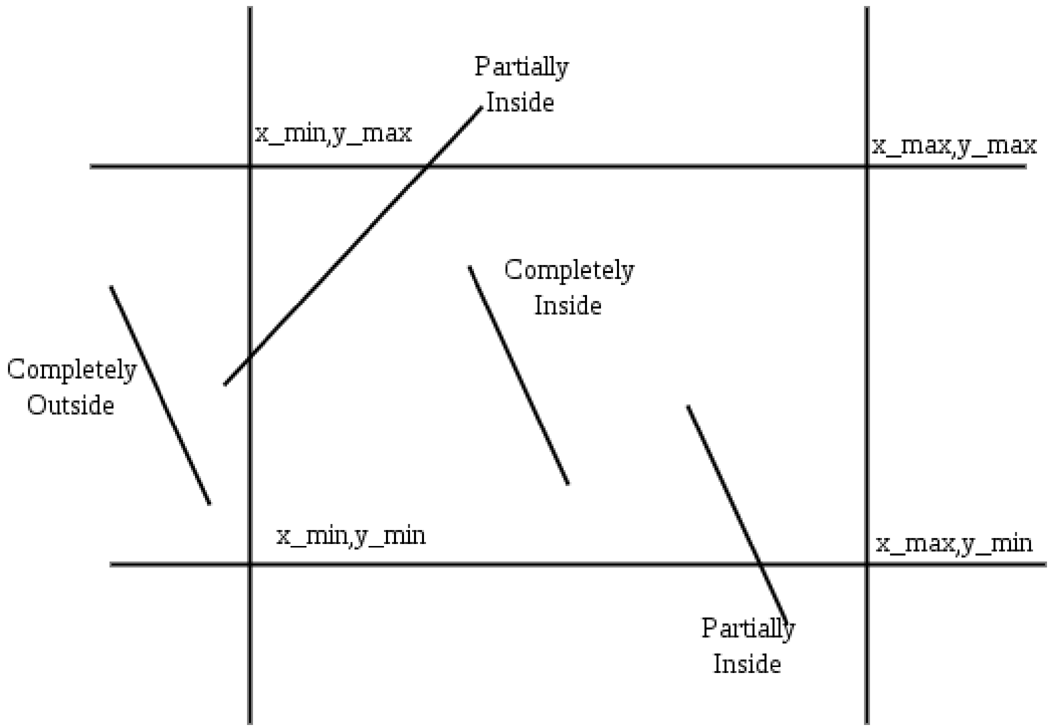
- A value of rkis calculated for each of these boundaries and value of u2 is the minimum of the set consisting of 1 and the calculated r values. If $u1>u2$, the line is completely outside the clip window and it can be rejected.

- Line intersection parameters are initialized to values $u1=0$ and $u2=1$. for each clipping boundary, the appropriate values for P and q are calculated and used by function

- Cliptest to determine whether the line can be rejected or whether the intersection parameter can be adjusted.
- When $p<0$, the parameter r is used to update u1.
- When $p>0$, the parameter r is used to update u2.

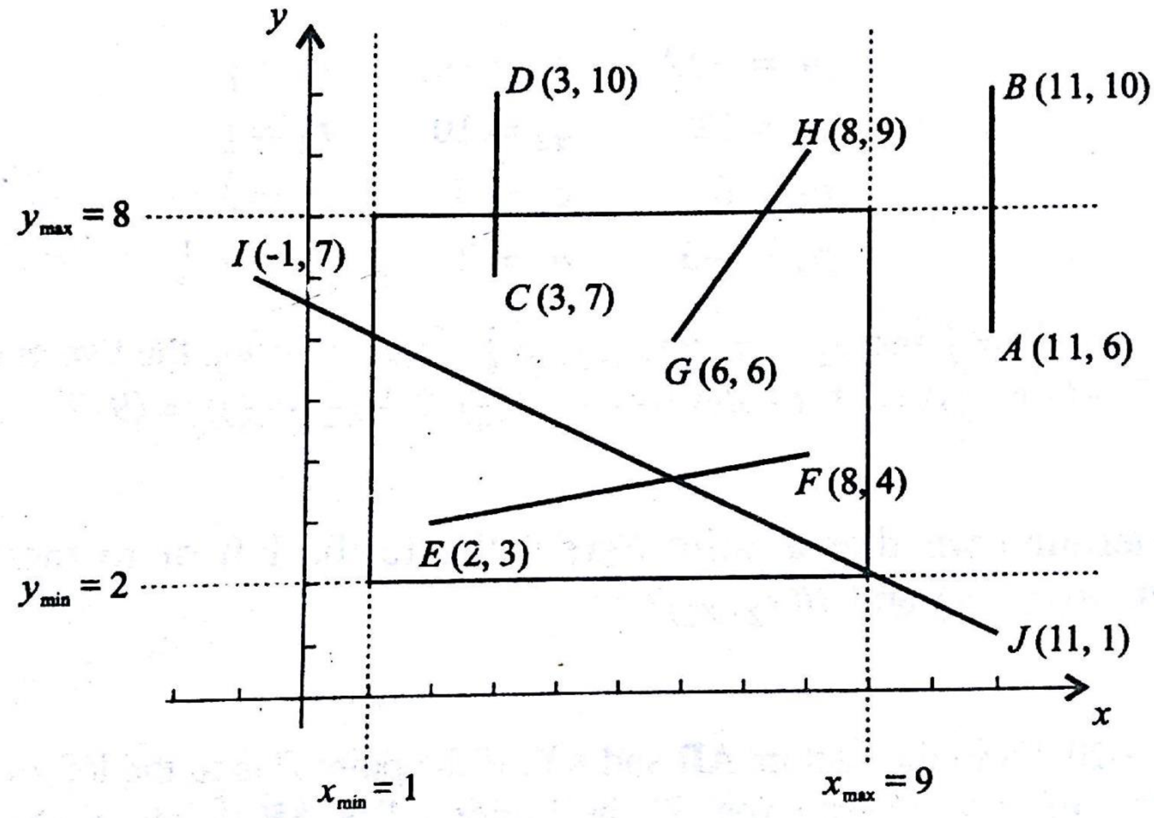
- If updating u1 or u2 results in $u1>u2$ reject the line,
- when $p=0$ and $q<0$, discard the line, it is parallel to and outside the boundary.
- If the line has not been rejected after all four value of p and q have been tested , the end points of clipped lines are determined from values of u1 and u2.

# Clipping window and lines status



# EXAMPLE

- Q: Use Liang Barksy algorithm to clip the lines as shown below.



## SOLUTION

For line $AB$, we have

$$\begin{array}{ll} p_1 = 0 & q_1 = 10 \\ p_2 = 0 & q_2 = -2 \\ p_3 = -4 & q_3 = 4 \\ p_4 = 4 & q_4 = 2 \end{array}$$

Since $p_2 = 0$ and $q_2 < -2$, $AB$ is completely outside the right boundary.

For line $CD$, we have

$$\begin{array}{lll} p_1 = 0 & q_1 = 2 & \\ p_2 = 0 & q_2 = 6 & \\ p_3 = -3 & q_3 = 5 & r_3 = -\frac{5}{3} \\ p_4 = 3 & q_4 = 1 & r_4 = \frac{1}{3} \end{array}$$

Thus $u_1 = \max(0, -\frac{5}{3}) = 0$ and $u_2 = \min(1, \frac{1}{3}) = \frac{1}{3}$. Since $u_1 < u_2$, the two endpoints of the clipped line are $(3, 7)$ and $(3, 7 + 3(\frac{1}{3})) = (3, 8)$.

For line $EF$, we have

$$\begin{array}{lll} p_1 = -6 & q_1 = 1 & r_1 = -\frac{1}{6} \\ p_2 = 6 & q_2 = 7 & r_2 = \frac{7}{6} \\ p_3 = -1 & q_3 = 1 & r_3 = -\frac{1}{1} \\ p_4 = 1 & q_4 = 5 & r_4 = \frac{5}{1} \end{array}$$

Thus $u_1 = \max(0, -\frac{1}{6}, -1) = 0$ and $u_2 = \min(1, \frac{7}{6}, 5) = 1$. Since $u_1 = 0$ and $u_2 = 1$, line $EF$ is completely inside the clipping window.

For line $GH$, we have

$$\begin{array}{lll} p_1 = -2 & q_1 = 5 & r_1 = -\frac{5}{2} \\ p_2 = 2 & q_2 = 3 & r_2 = \frac{3}{2} \\ p_3 = -3 & q_3 = 4 & r_3 = -\frac{4}{3} \\ p_4 = 3 & q_4 = 2 & r_4 = \frac{2}{3} \end{array}$$

Thus $u_1 = \max(0, -\frac{5}{2}, -\frac{4}{3}) = 0$ and $u_2 = \min(1, \frac{3}{2}, \frac{2}{3}) = \frac{2}{3}$. Since $u_1 < u_2$, the two endpoints of the clipped line are $(6, 6)$ and $(6 + 2(\frac{2}{3}), 6 + 3(\frac{2}{3})) = (7\frac{1}{3}, 8)$.

For line $IJ$, we have

$$\begin{array}{lll} p_1 = -12 & q_1 = -2 & r_1 = \frac{1}{6} \\ p_2 = 12 & q_2 = 10 & r_2 = \frac{5}{6} \\ p_3 = 6 & q_3 = 5 & r_3 = \frac{5}{6} \\ p_4 = -6 & q_4 = 1 & r_4 = -\frac{1}{6} \end{array}$$

Thus $u_1 = \max(0, \frac{1}{6}, -\frac{1}{6}) = \frac{1}{6}$ and $u_2 = \min(1, \frac{5}{6}, \frac{5}{6}) = \frac{5}{6}$. Since $u_1 < u_2$, the two endpoints of the clipped line are $(-1 + 12(\frac{1}{6}), 7 + (-6)(\frac{1}{6})) = (1, 6)$ and $(-1 + 12(\frac{5}{6}), 7 + (-6)(\frac{5}{6})) = (9, 2)$.

- THANK YOU