

The Liang-Barsky Algorithm

The Liang-Barsky Algorithm returns the normals of the sides[of the rectangle] where the segment intersects. This algorithm also returns nil if the segment doesn't touch the rectangle.

The Liang-Barsky Algorithm is a line clipping algorithm. It is far more efficient than the Cohen-Sutherland Algorithm because it can be extended to 3-Dimensional clipping, plus it is overall faster.

This algorithm uses the concepts of the parametric equation of a line and the inequalities describing the range of the clipping window which is used to determine the intersections between the line and the clip window. The parametric equation is as follows:

$$X = x_1 + t(x_2 - x_1)$$

$$Y = y_1 + t(y_2 - y_1) \quad \Rightarrow t \text{ is between } 0 \text{ and } 1$$

Point-clipping conditions in parametric form:

$$x_w^{\min} \leq x_1 + t(x_2 - x_1) \leq x_w^{\max}$$

$$y_w^{\min} \leq y_1 + t(y_2 - y_1) \leq y_w^{\max}$$

The inequalities can be expressed as:

$$tp_k \leq q_k \quad \Rightarrow k = 1(\text{left boundary}), 2(\text{right boundary}), 3(\text{top boundary}), 4(\text{bottom boundary})$$

p and q are defined as:

$$p_1 = -(x_2 - x_1), \quad q_1 = x_1 - x_w^{\min} \text{ (Left Boundary)}$$

$$p_2 = (x_2 - x_1), \quad q_2 = x_w^{\max} - x_1 \text{ (Right Boundary)}$$

$$p_3 = -(y_2 - y_1), \quad q_3 = y_1 - y_w^{\min} \text{ (Bottom Boundary)}$$

$$p_4 = (y_2 - y_1), \quad q_4 = y_w^{\max} - y_1 \text{ (Top Boundary)}$$

p value for the boundary is 0 when the line is parallel to a view window boundary.

The conditions followed determine the position of the line:

Condition	Position of Line
$p_k = 0$	parallel to the clipping boundaries
$p_k = 0$ and $q_k < 0$	outside the clipping boundary
$p_k = 0$ and $q_k = 0$	inside parallel clipping boundary
$p_k < 0$	line proceeds from outside to inside

$p_k > 0$

line proceeds from inside to outside

Reference: <https://www.geeksforgeeks.org/liang-barsky-algorithm/>

The Minkowski Algorithm

The Minkowski Algorithm, also known as the Minkowski Difference, is the difference of two objects such as two rectangles where each point from one rectangle is subtracted from each point of the other rectangle. An example would be $A + -B$. Both objects will collide if the difference contains the point 0.

Reference: <https://slidetodoc.com/physics-for-games-programmers-tutorial-motion-and-collision/>