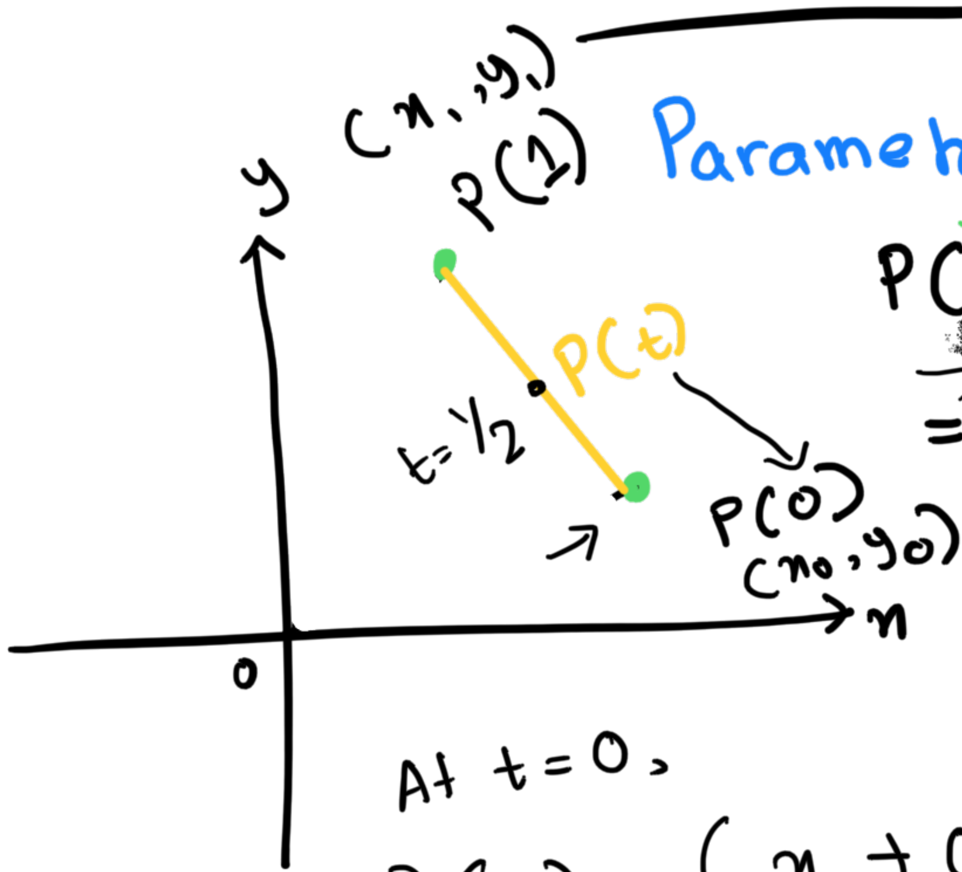
Cyrus Beck (Clipping)



Parametric equation,

$$P(t) = P_0 + t\,(P_1 - P_0)$$

$$= (x_0, y_0) + t\,(x_1 - x_0,\ y_1 - y_0)$$

$$= (x_0 + t(x_1 - x_0)),\ (y_0 + t(y_1 - y_0))$$

At $t = 0$,

$$P(0) = (x_0 + 0(x_1 - x_0)),\ (y_0 + 0(y_1 - y_0))$$

$$P(0) = (x_0, y_0) \leftarrow$$

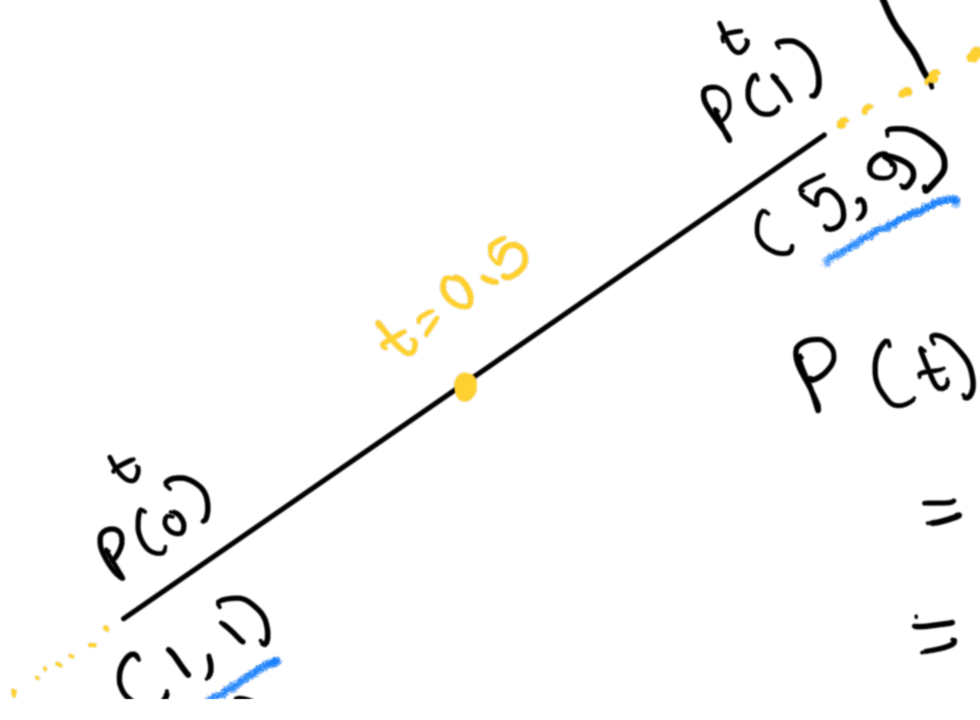
At $t = 1$

$$P(1) = (\cancel{x_0} + 1(x_1 - \cancel{x_0})),\ (\cancel{y_0} + 1(y_1 - \cancel{y_0}))$$

$$P(1) = (x_1, y_1)$$

Midpoint,

$$P\left(\tfrac{1}{2}\right) = \left(\frac{x_0 + x_1}{2},\ \frac{y_0 + y_1}{2}\right)$$



$$P(t) = P_0 + t\,(P_1 - P_0)$$

$$= (1, 1) + t\,(5 - 1,\ 9 - 1)$$

$$= (1 + 4t,\ 1 + 8t)$$

$(-0.2, -1.4)$

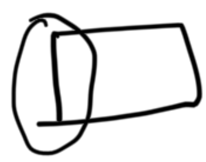
$$P(0) = (1+4\cdot 0,\ 1+8\cdot 0)$$
$$= (1, 1)$$
$$P(1) = (1+4\cdot 1,\ 1+8\cdot 1)$$
$$= (5, 9)$$
$$P(0.5) = (1+4\cdot 0.5,\ 1+8\cdot 0.5)$$
$$= (3, 5)$$
$$P(1.3) = (1+4\times 1.3,\ 1+8\times 1.3)$$
$$= (6.2,\ 11.4)$$
$$P(-0.3) = (1+4\times 0.3,\ 1+8\times 0.3)$$
$$= (-0.2, -1.4).$$

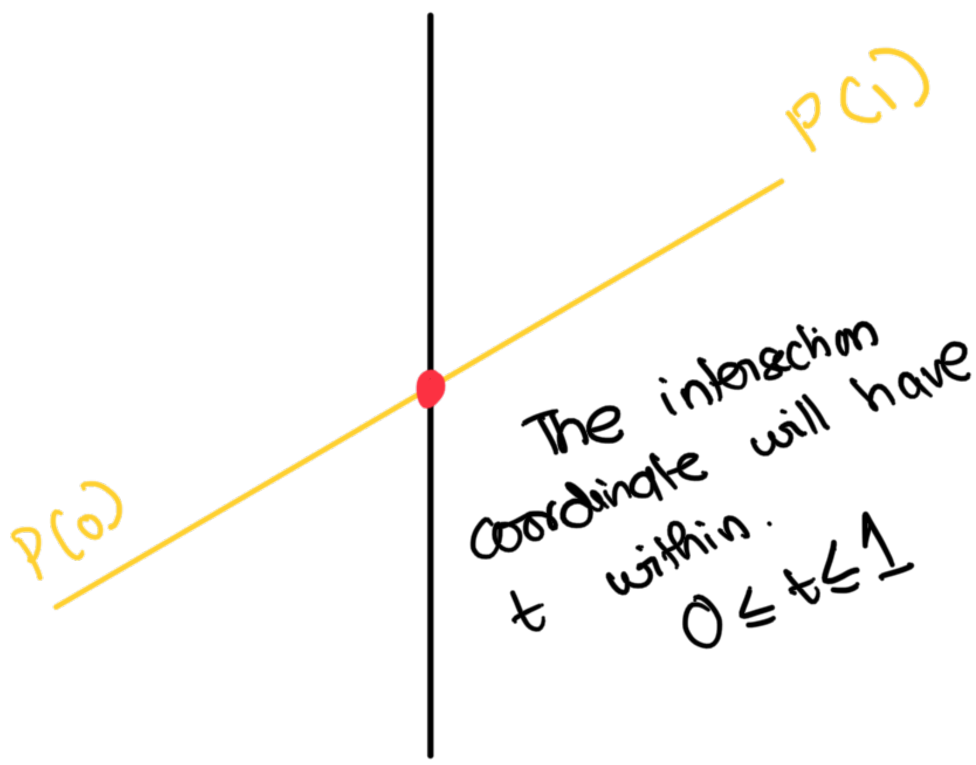
Condition

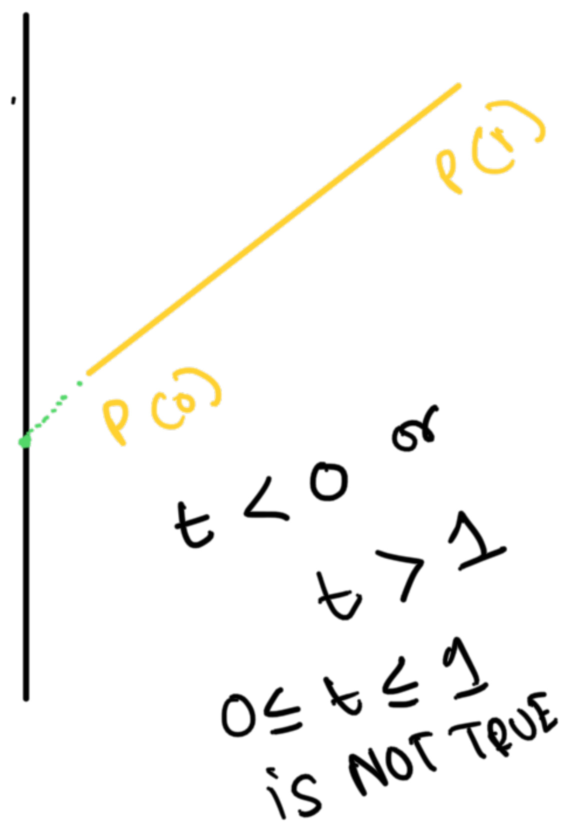
→ $0 \le t \le 1$ points lie inside the line.

→ $t < 0$ or $t > 1$ points lie outside the line.

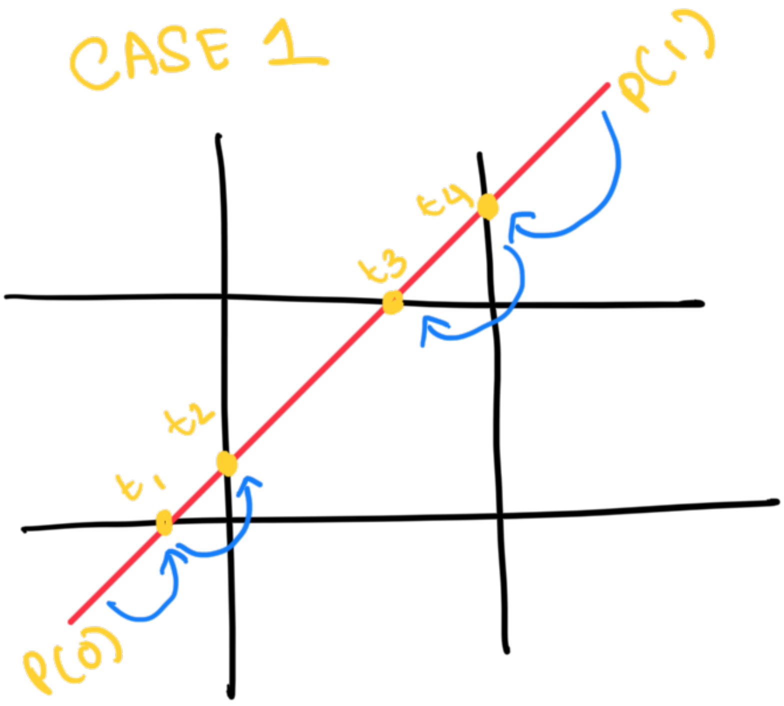
Boundary





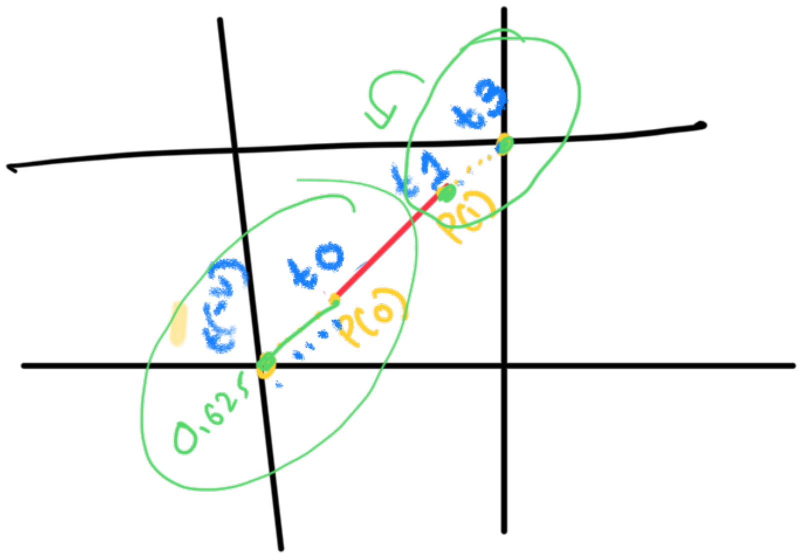


CASE 1



This line is partially inside $t_1 \dots t_4$ within $0 \dots 1$

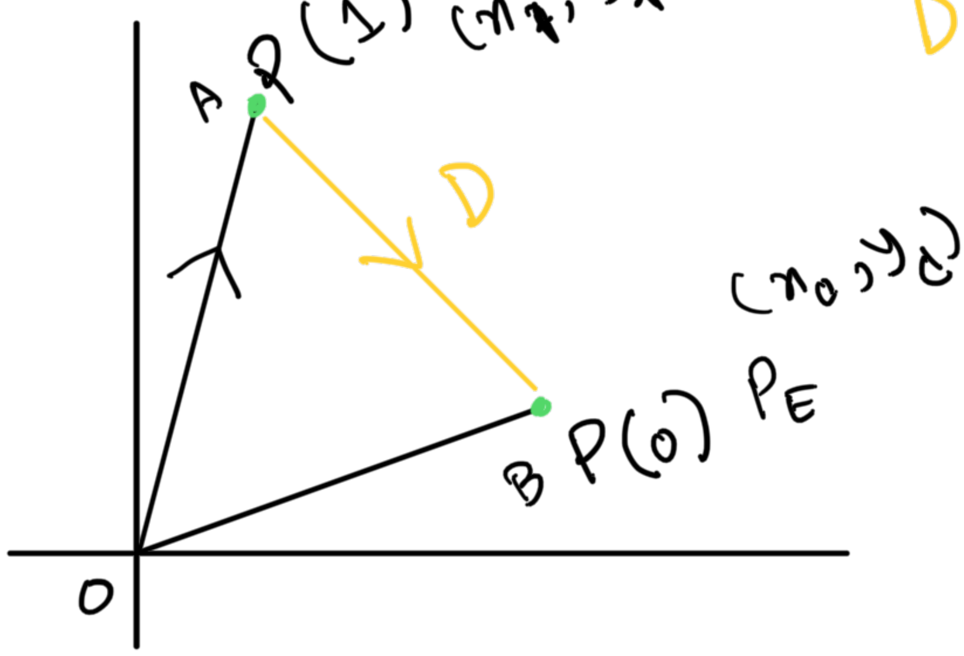
CASE II



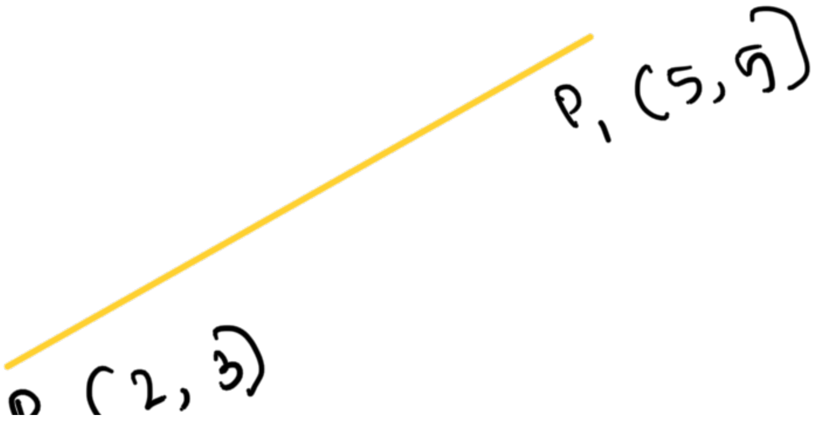
This line is completely inside.

$t < 0$ or $t > 1$

Directional Vector



$$D = P_1 - P_0$$
$$= (x_1 - x_0, y_1 - y_0)$$

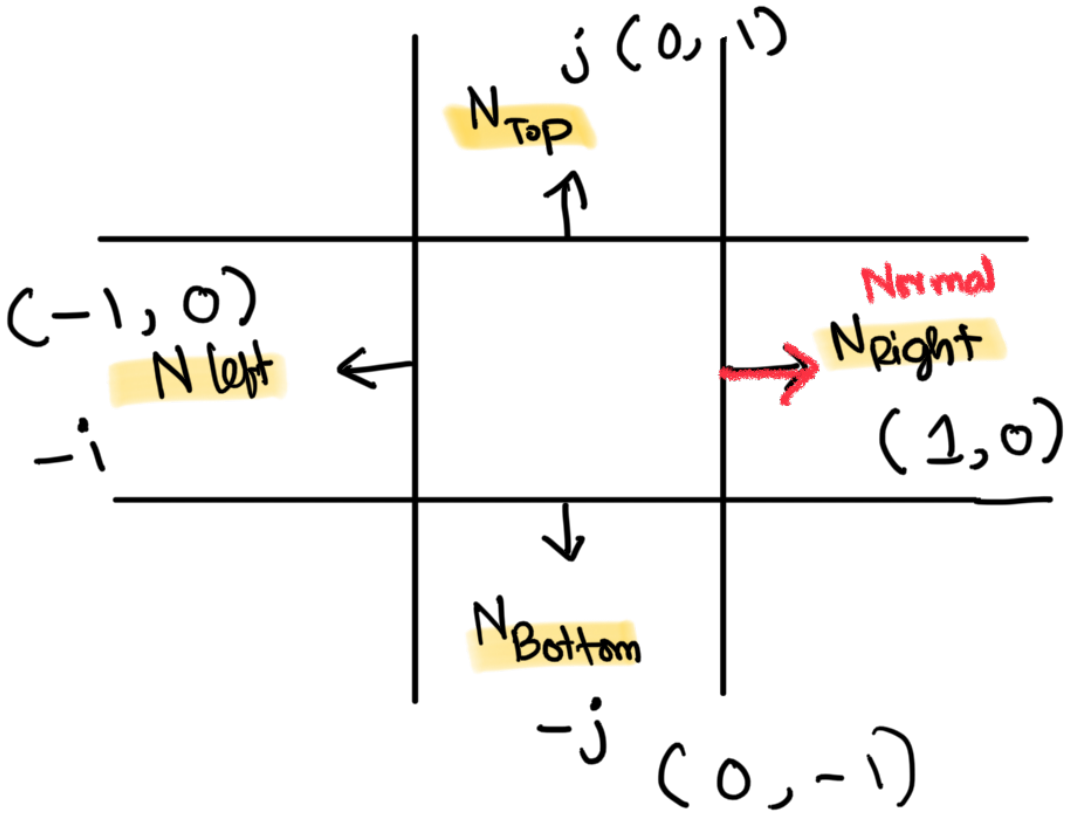


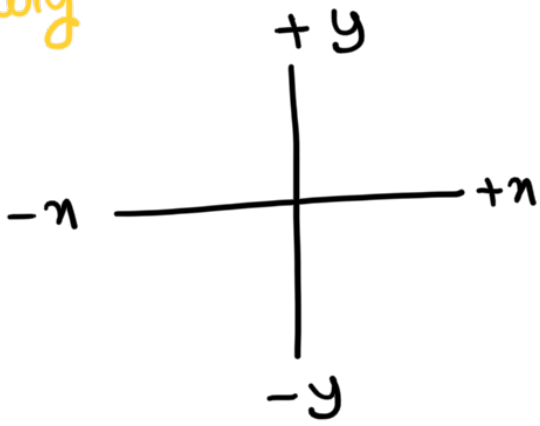
$$D = (5-2, 5-3)$$
$$D = (3, 2)$$

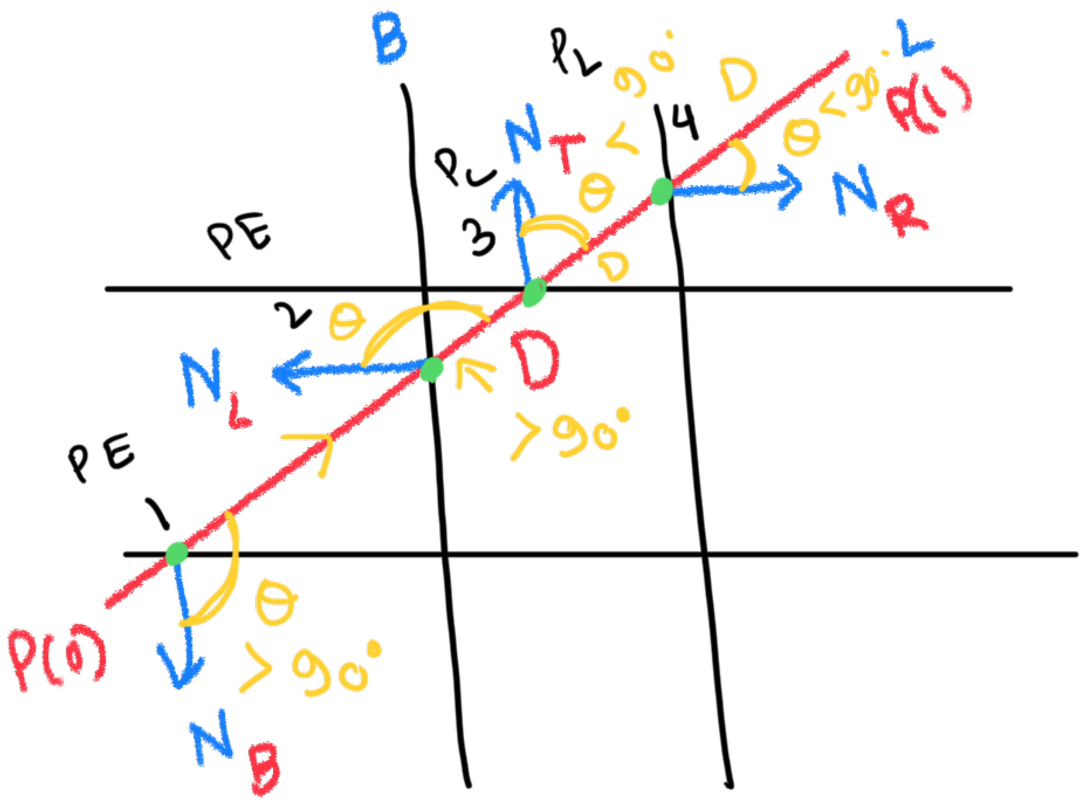
r_0

$D = 3i + 2j$ ←

Normal Vector to boundary







Places where we get $\theta > 90°$

Potentially Entering

$N_i \cdot D < 0$

Places where we get $\theta < 90°$

Potentially Leaving.

$N_i \cdot D > 0$

Cyrus Algorithm

1) Calculate t values of intersection points with each boundaries.

2) Classify intersection points whether it is P_E / P_L.

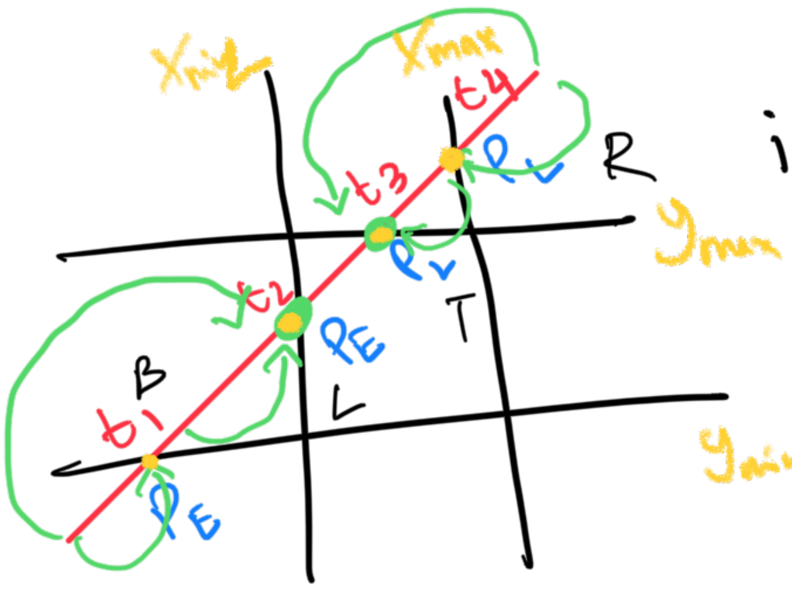
$N_i \cdot D < 0$ P_E ←

$N_i \cdot D > 0$ P_L

$N_i \cdot D > 0$ ... L

→ Select P_E with highest t / t_E

→ Select P_L with lowest t / t_L



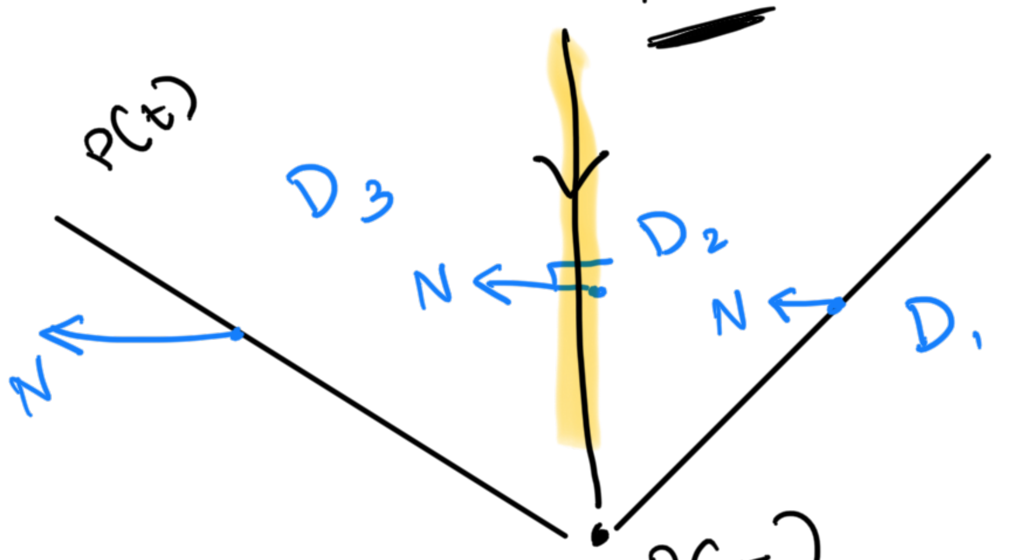
if $t_E > t_L$ line segment is outside the clipping window

$t_E \le t_L$ this line is in my clipping

Clipped line coordinates →

$$P(t) = (x_0, y_0) + t \times D$$

$$= (x_0, y_0) + t(P_1 - P_0)$$



N, D, t

$$N \cdot D = 0$$

$$N(P(t) - P(E))$$

$$N \cdot (P_0 + t(P_1 - P_0) - P_E) = 0$$

$$N(P_0 - P_E) + N \cdot t(P_1 - P_0) = 0$$

$$t = \frac{N \cdot (P_0 - P_E)}{-N(P_1 - P_0)}$$

$$t = \frac{N_i\,(P_0 - P_E)}{-N \cdot D}$$

$N \cdot D$

$N(P_1 - P_0)$

Boundary	N	$N(P_0 - P_E)$	$(P_1 - P_0)N_i$ / $D \cdot N_i$	Time (t)
Top	$(0,1)$	$y_0 - y_{max}$	$(y_1 - y_0)$	$\frac{y_{max} - y_0}{y_1 - y_0}$
Bottom	$(0,-1)$	$-(y_0 - y_{min})$	$-(y_1 - y_0)$	$\frac{y_{min} - y_0}{y_1 - y_0}$
Right	$(1,0)$	$x_0 - x_{max}$	$x_1 - x_0$	$\frac{x_{max} - x_0}{x_1 - x_0}$
left	$(-1,0)$	$-(x_0 - x_{min})$	$-(x_1 - x_0)$	$\frac{x_{min} - x_0}{x_1 - x_0}$

$N \cdot (P_0 - P_E)$

T y

B y

Boundary	N_i	$N_i \cdot D$	t	P_E / P_L	max t_E	min t_L
Top	$(0,1)$	< 0	$t = ?$	P_E	max t_E	
Bottom	$(0,-1)$	> 0	$t = ?$	P_L		
Right	$(1,0)$	> 0	$t = ?$	P_L		min t_L
left	$(-1,0)$	$<$	$t = ?$	P_E		

→ $t_{E\,max} > t_{L\,min}$ line segment is outside

→ else, it is clip section

$P(t_{E_{max}}) =$ $P(t_{L_{min}}) = (\quad)$

Calculate the value of t & clipped coordinates of the line given below for all edges & specify whether they are entering or leaving t.

Given (0, 0) to (300, 200) be the clip region.

$x_{min}\ y_{min}$ $\quad x_{max},\ y_{max}$

1) $(-250, 200)$ to $(150, 100)$.

$\quad x_0 \quad y_0 \qquad x_1 \quad y_1$

Boundary:

$x_{min} = 0,\ x_{max} = 300,\ y_{min} = 0,\ y_{max} = 200$

Points:

$x_0 = -250 \quad y_0 = 200 \quad x_1 = 150 \quad y_1 = 100$

$$D = P_1 - P_0$$
$$= (x_1 - x_0,\ y_1 - y_0)$$
$$= ((150 - (-250)),\ (100 - 200))$$
$$D = (400, -100)$$
$$D = 400i - 100j$$

Boundary	N_i	$N_i \cdot D$	t	P_E/P_L	t_E (max)	t_L (min)
x_{min} left	$(-1, 0)$	$400 \times (-1) + (-100) \times (0) = -400$	$x_{min} - x_0 / x_1 - x_0 = 0 - (-250) / 150 - (-250) = 0.625$	$N_i \cdot D < 0$ P_E	0.625	1.375
x_{max} Right	$(1, 0)$	$400 \times 1 + (-100) \times 0 = 400$	$x_{max} - x_0 / x_1 - x_0 = 1.375$	>0 P_L	0.625	1.375
y_{min} …	( )	100	$y_{min} - y_0 / y_1 - y_0$	>0 …		…

y_{min}	Bottom	(0,-1)		≥ 2	P_L	0.625	1.375
y_{max}	Top	(0,1)	-100	$\frac{y_{max}-y_0}{y_1-y_0} = 0$	<0 P_E	0.625	1.375

$t_E(0.625) < t_L(1.375)$

Line is in clip section

$$P(t) = (x_0, y_0) + t \times D$$

$$P(0.625) = (-250, 200) + 0.625\,(400, -100)$$

$$= \left((-250 + 0.625 \times 400),\ (200 + 0.625 \times (-100))\right)$$

$$= (0, 137.5)$$

0.99

$$P(0.99) = (-250, 200) + 0.99\,(400, -100)$$

$$= \left((-250 + 0.99 \times 400),\ (200 + 0.99 \times (-100))\right)$$