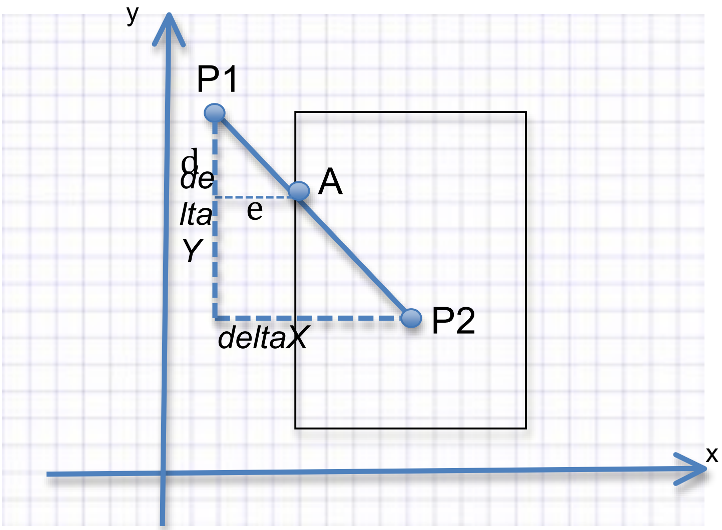
CSCI 4250/5250 Cohen-Sutherland Clipping

- **The algorithm:** https://www.cs.mtsu.edu/~cen/4250/private/lectures/ClippingAlg.html
- **Deriving the clipping equations:**



Clip from the left: given $A.x = W.left$, compute $A.y$:

$$\frac{d}{deltaY} = \frac{e}{deltaX}$$

$$\frac{d}{e} = \frac{deltaY}{deltaX} = \frac{P1.y - P2.y}{P2.x - P1.x} = -\frac{P1.y - P2.y}{P1.x - P2.x} = -k$$

$$d = P1.y - A.y$$

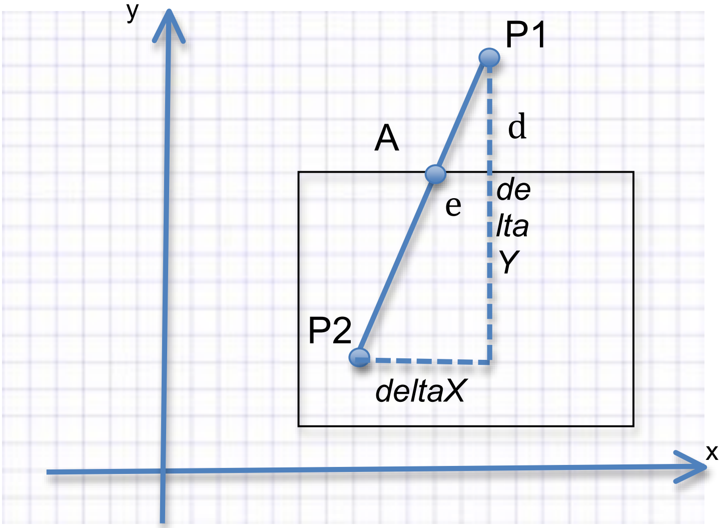
$$e = A.x - P1.x$$

$$\frac{P1.y - A.y}{A.x - P1.x} = -k$$

$$P1.y - A.y = -k * (A.x - P1.x)$$

$$A.y - P1.y = k * (W.left - P1.x)$$

$$A.y = P1.y + k * (W.left - P1.x)$$



Clip from the top, given $A.y = W.top$, compute $A.x$:

$$\frac{d}{deltaY} = \frac{e}{deltaX}$$

$$\frac{d}{e} = \frac{deltaY}{deltaX} = \frac{P1.y - P2.y}{P1.x - P2.x} = k$$

$$d = P1.y - A.y$$

$$e = P1.x - A.x$$

$$\frac{P1.y - A.y}{P1.x - A.x} = k$$

$$\frac{P1.x - A.x}{P1.y - A.y} = \frac{1}{k}$$

$$P1.x - A.x = \frac{1}{k} * (P1.y - A.y)$$

$$P1.x - A.x = \frac{1}{k} * (P1.y - W.top)$$

$$A.x = P1.x - \frac{1}{k} * (P1.y - W.top)$$

$$A.x = P1.x + \frac{1}{k} * (W.top - P1.y)$$

- **Clipping equations:**

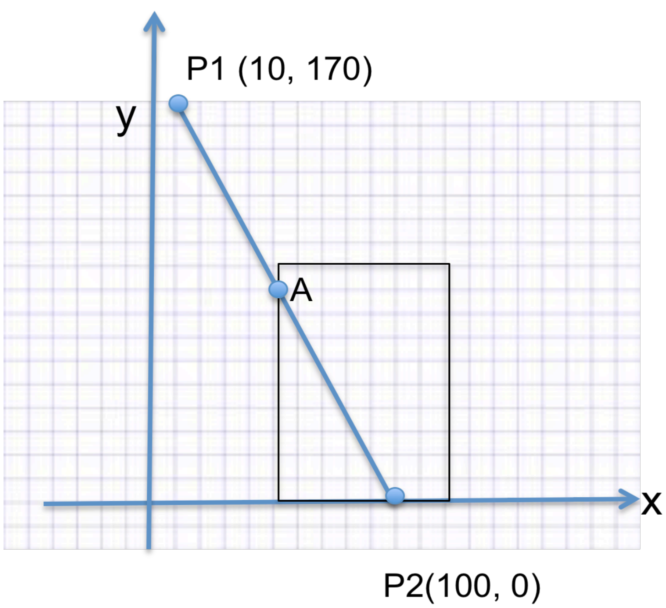
(clip from left: A.y=P1.y + k*(W.left - P1.x)
from right: A.y=P1.y + k*(W.right - P1.x)
from above: A.x=P1.x+1/k *(W.top - P1.y)
from below: A.x=P1.x+1/k*(w.bottom - P1.y)
k is the slope of the line that connects P1 and P2)

- **Practice Problem:**
  Given a window (50, 120, 0, 100), apply the Cohen-Sutherland Clipping algorithm to determine the segment of line that will be displayed on screen:
    - p1(50, 40), p2(100, 20)
    - p1(10, 120), p2(70, 120)
    - p1(10, 170), p2(100, 0)
    - P1(20, -10) and P2(200, 200)

(1) clip the line segment: p1(50, 40), p2(100, 2)
outcode for p1: 0000
outcode for p2: 0000
0000 or 0000 --> 0 trivial accept

(2) clip the line segment: p1(10, 120), p2(70, 120)
outcode for p1: 1001
outcode for p2: 1000
1001 or 1000: --> not 0
1001 and 1000: 1000 trival reject

(3) clip the line segment: p1(10, 170), p2(100, 0)
outcode for p1: 1001
outcode for p2: 0000
1001 or 0000 --> 1001, not 0
1001 and 0000 --> 0
need clipping



Clip from the left :

$$k = \frac{P1.y - P2.y}{P1.x - P2.x} = \frac{170 - 0}{10 - 100} = -\frac{17}{9}$$

$$P1.y = A.y + k * (W.left - P1.x)$$

$$= 170 + -\frac{17}{9} * (50 - 10) = 94.4$$

<u>**A is (50, 94.4)**</u>

Now check the line segment (p1, A) and (A, p2)
for line segment (A, p2)
p2: 0000

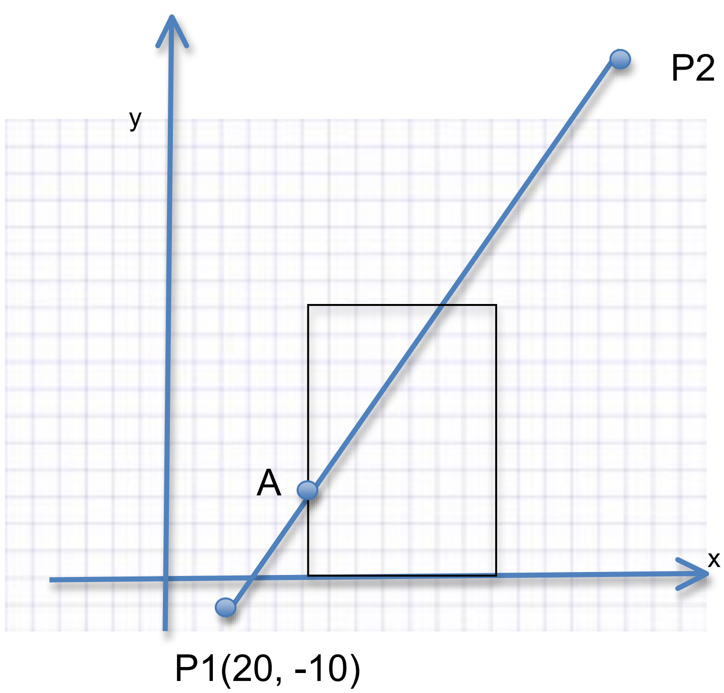
A: 0000
A or p2 is 0 → trival accept, draw the line A-p2

p1: 1001
A: 0000
p1 OR A not 0
p1 AND A = 0 trivial reject

(4) clip line segment P1(20, -10) and P2(200, 200)

(clip from left: A.y=P1.y + k*(W.left - P1.x)
from right: A.y=P1.y + k*(W.right - P1.x)
from above: A.x=P1.x+1/k *(W.top - P1.y)
from below: A.x=P1.x+1/k*(w.bottom - P1.y))

P1 outcode:0101
P2 outcode: 1010
P1 or P2: 0101 or 1010 --> 1111 (not 0)
P1 and P2: 0101 and 1010 = 0 → need clip



Clip from the left:

$$k = \frac{P1.y - P2.y}{P1.x - P2.x} = \frac{-10-200}{20-200} = \frac{7}{6}$$

$$P1.y = A.y + k*(W.left - P2.x)$$

$$= -10 + \frac{7}{6}*(50-20) = 25$$

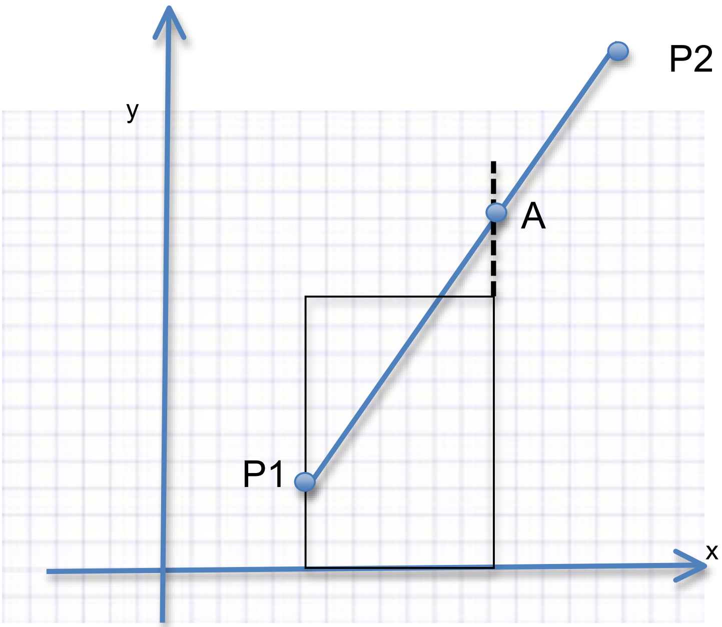
<u>A (50, 25)</u>

It should be (W.left – P1.x) ^^^^

now check line p1(20, -10) and A(50, 25) and
line A(50, 25) and P2(200, 200)
for p1--A line
one point on the left boundary, the other point outside left boundary --> reject

for A--p2 line
continue with clipping
rename point A as P1, so the new line segment is
P1(50, 25) P2(200, 200)

A (120, 103.12)



Clip from the right:

$$k = \frac{7}{6}$$

$$A.y = P1.y + k * (W.right - P1.x)$$

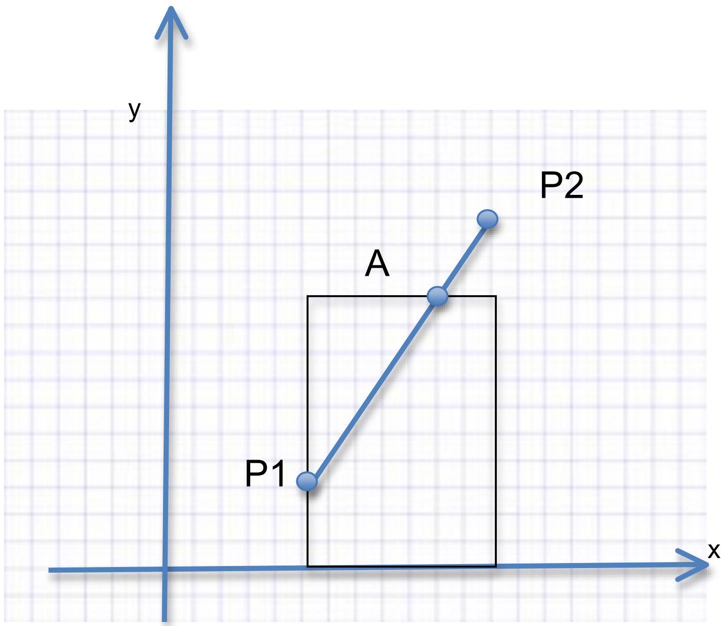
$$= 25 + \frac{7}{6} * (120 - 50) = 103.12$$

For the segment A-p2:
A is on the right boundary, p2 is to the right of the window → reject

For the segment A-P1:
p1(50, 25), A(120, 103.12)
p1: 0000
A: 1000
p1 or A not 0, p1 and A = 0
the segment p1 -- A needs further clipping:

rename A to p2(120, 103.12)
clipping from the top
P1 (50, 25), P2(120, 103.12)

A (114.28, 100)



Clip from the top:

$$k = \frac{7}{6}$$

$$A.x = P1.x + \frac{1}{k} * (W.top - P1.y)$$

$$= 50 + \frac{6}{7} * (100 - 25) = 114.28$$

Final segment : p1(50, 25) p2(114.28, 100)