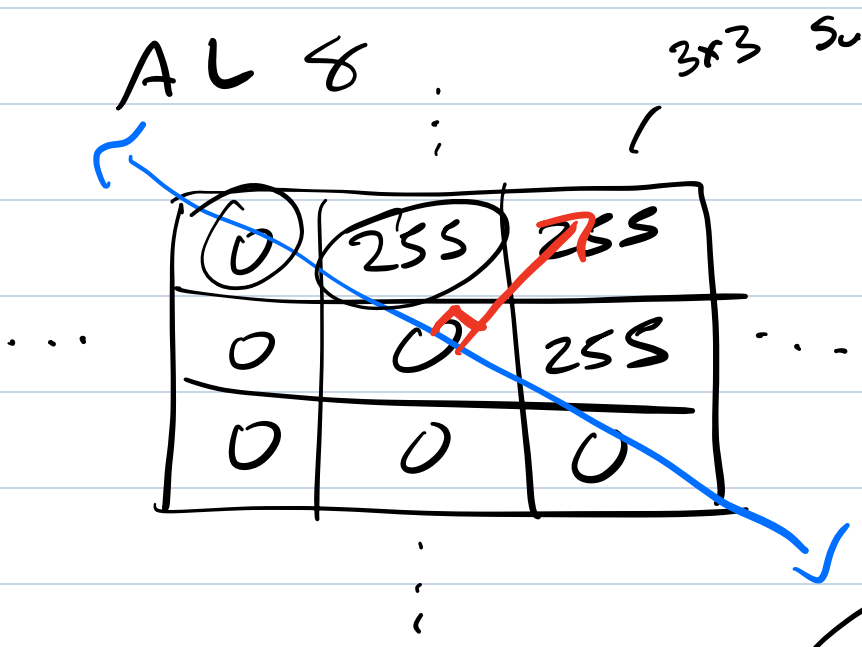
Edge detection cont.



- Sobel filters

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \cdot L$$

$$\text{Edge Normal} = \begin{bmatrix} g_x \\ g_y \end{bmatrix}$$

Scalar typically $\frac{1}{8}$

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \cdot L$$

0	255	255
0	0	255
0	0	0

g_x

$-1(0) + 0(255) + 1(255)$

$+ -2(0) + 0(0) + 2(255)$

$+ -1(0) + 0(0) + 1(0)$

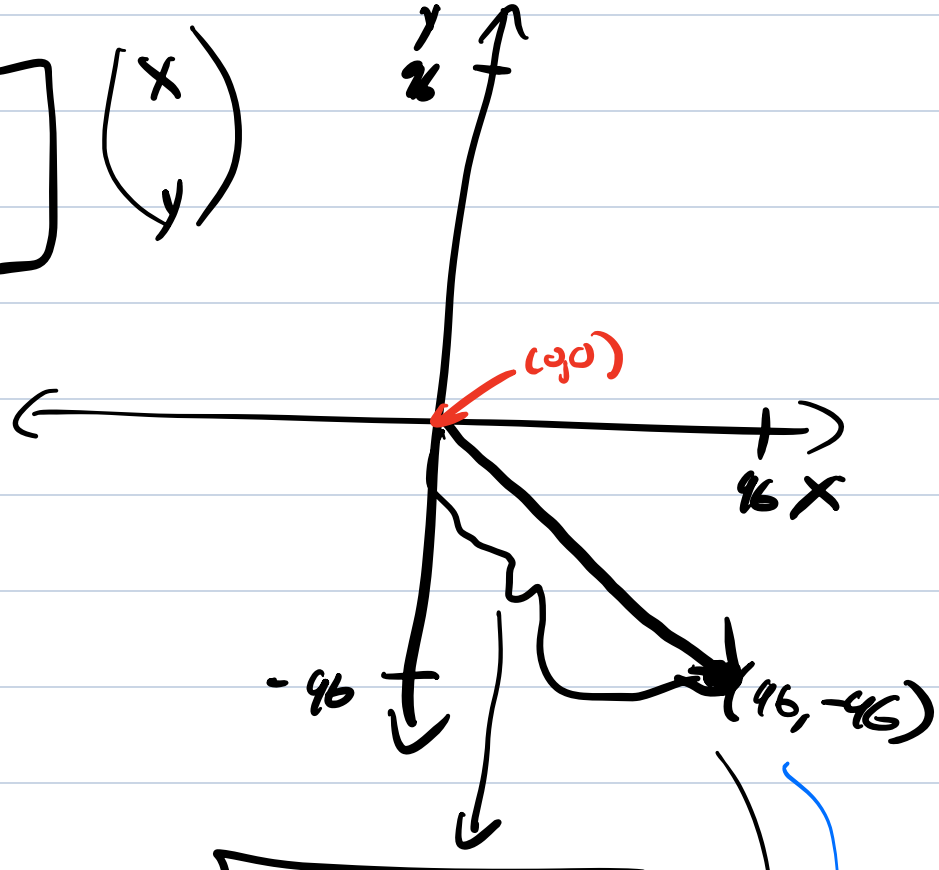
$\Rightarrow 3 \cdot 255 = 765 \cdot \frac{1}{8} \approx \boxed{96}$

g_y

$$-1(0) + -2(255) + -1(255)$$
$$+ 0(0) + 0(0) + 0(255)$$
$$+ 1(0) + 2(0) + 1(0)$$

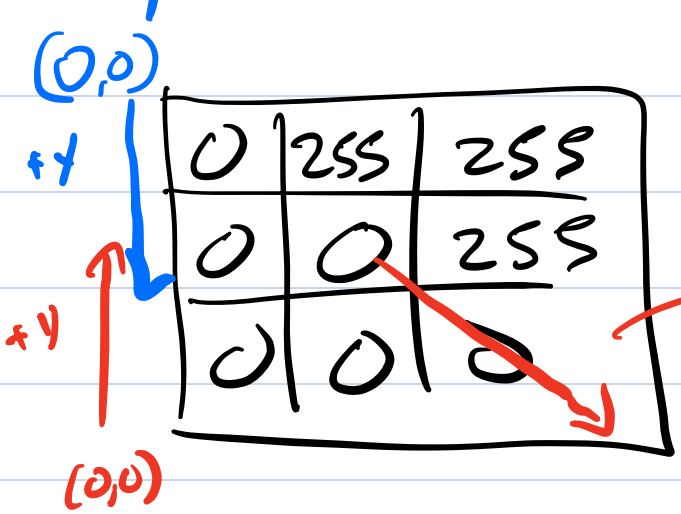
$$= -765 \cdot \frac{1}{8} = \boxed{-96}$$

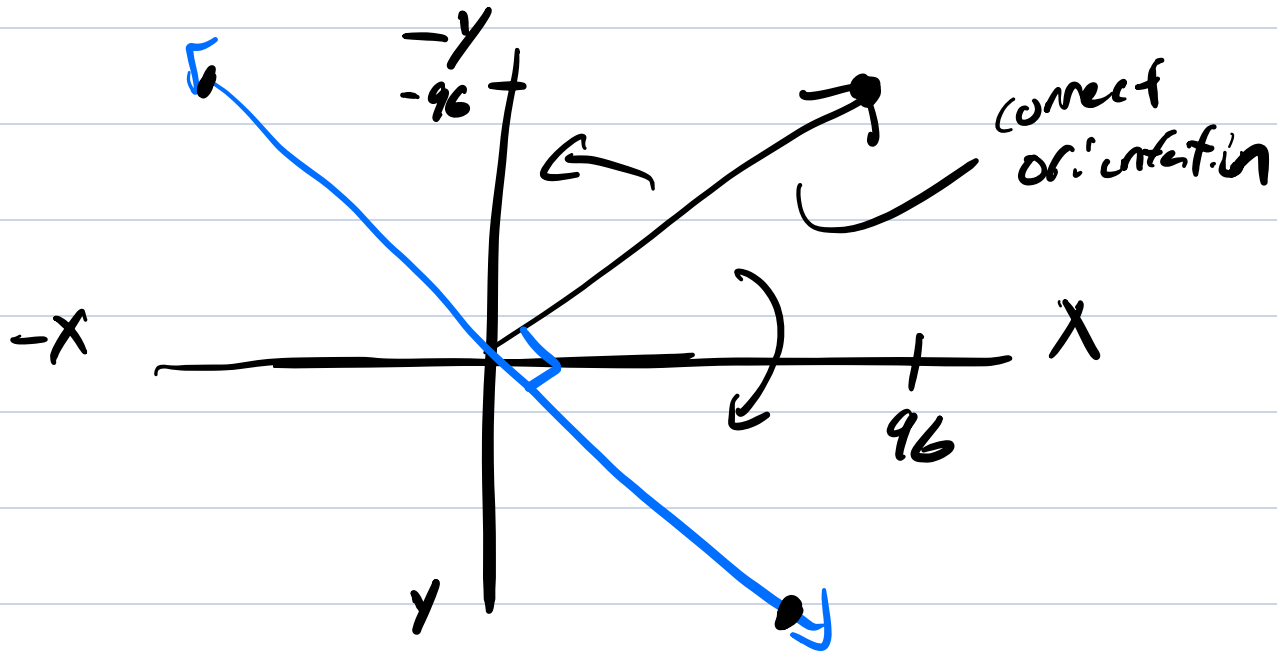
$$EN = \begin{bmatrix} 96 \\ -96 \end{bmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$



Edge magnitude $= \sqrt{g_x^2 + g_y^2}$

$\rightarrow c^2 = \sqrt{a^2 + b^2}$





$$EN = \begin{bmatrix} 96 \\ -96 \end{bmatrix} \qquad ED = \begin{bmatrix} 96 \\ 96 \end{bmatrix}$$

or

$$ED = \begin{bmatrix} -96 \\ -96 \end{bmatrix}$$

Canny operator

- Many different Canny operators

* Most widely used edge detector.

• returns a single response per edge.

(edges are 1 pixel wide)

Step 1 - apply a low-pass spatial frequency filter

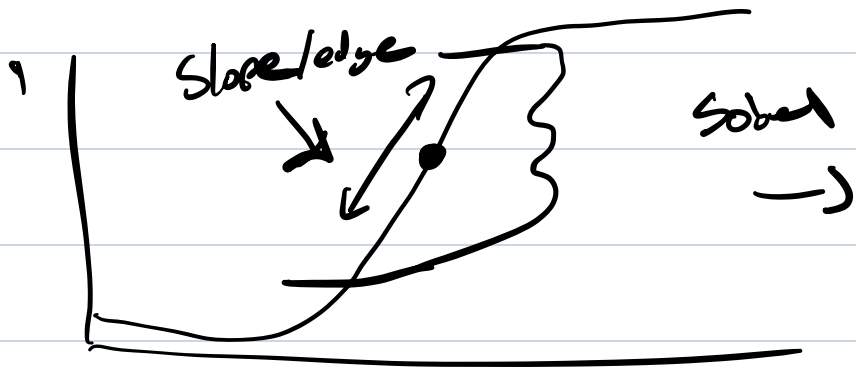
(Gaussian blur)

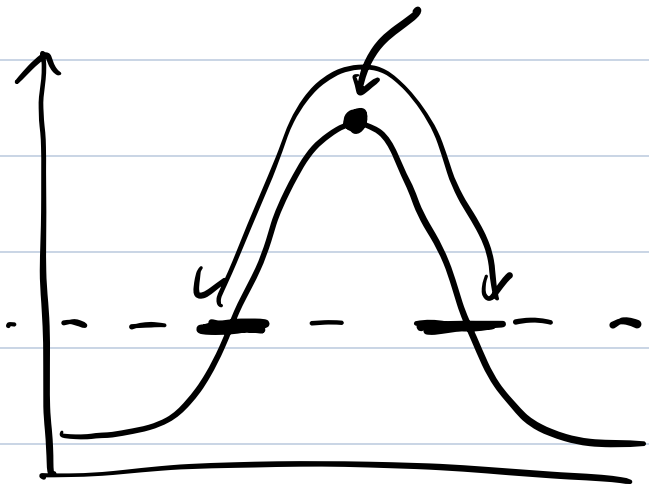
Step 2 - apply a first-order differential mask.

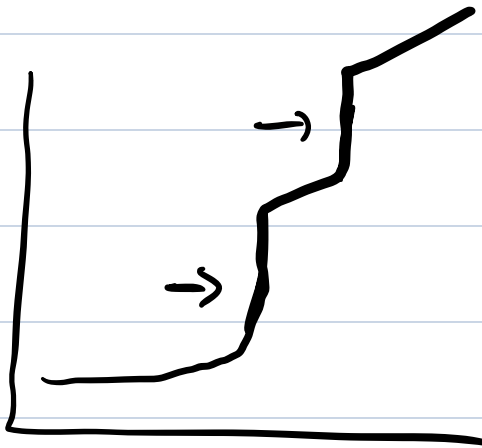
(Sobel operator)

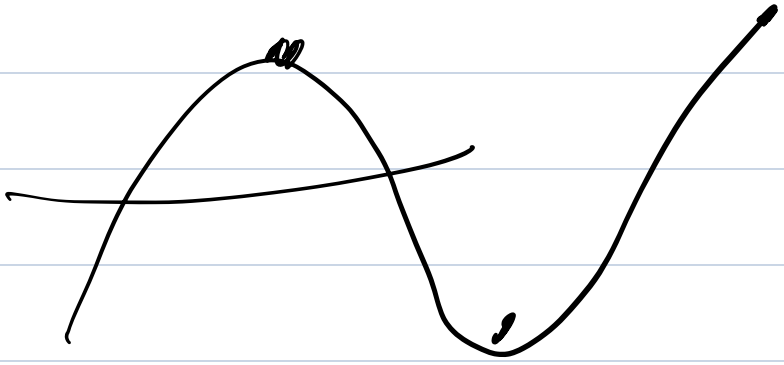
Step 3 - non maximum suppression involving subpixel interpolation of pixel edge magnitude intensity.

(· Determine the local edge normal and direction and move either way along the normal (slope) the current location is a local maximum.)





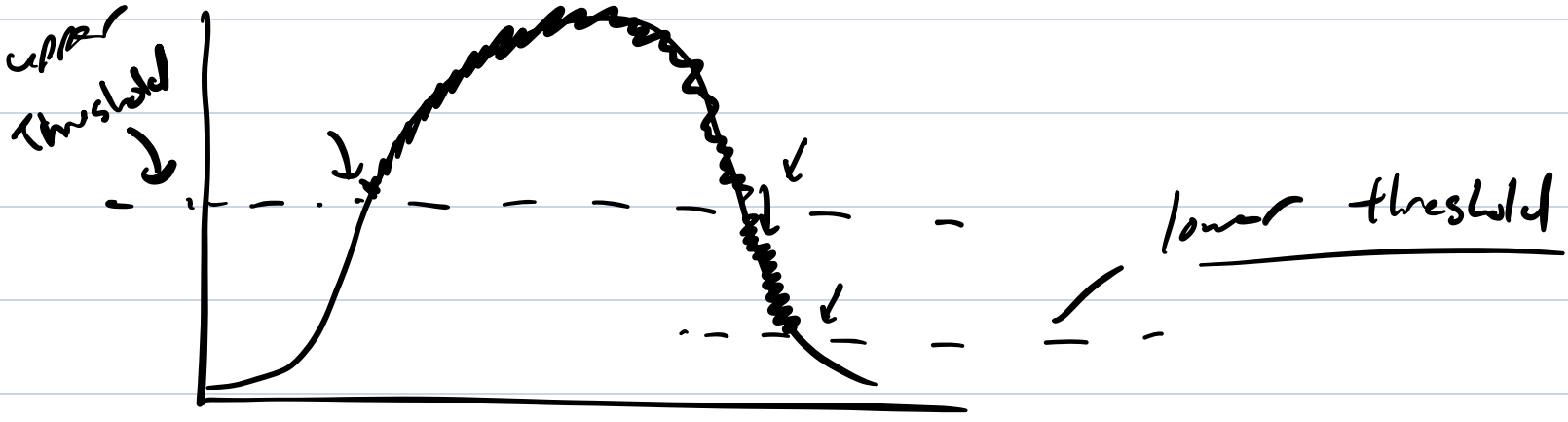




4) Histeresis thresholding

Normal thresholding

Hysteresis thresholding - adds a lower bound.



- to count as an edge, the value must first past upper threshold.

- Extends edges until it reaches the lower threshold.