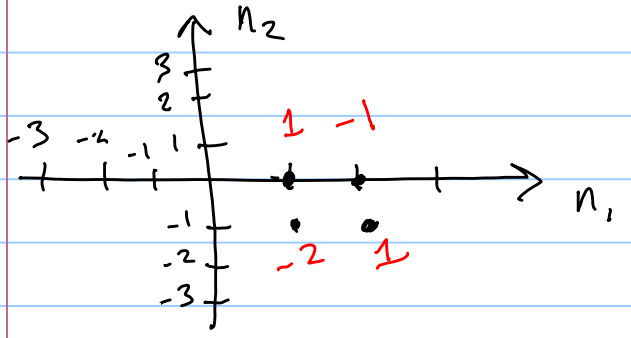
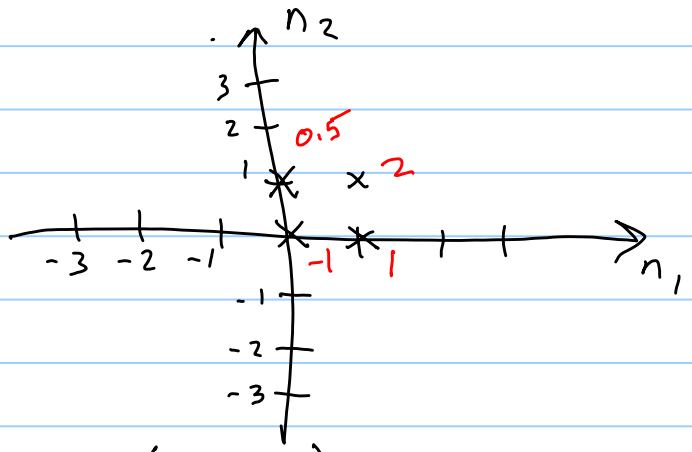
Note Title 2/5/2010

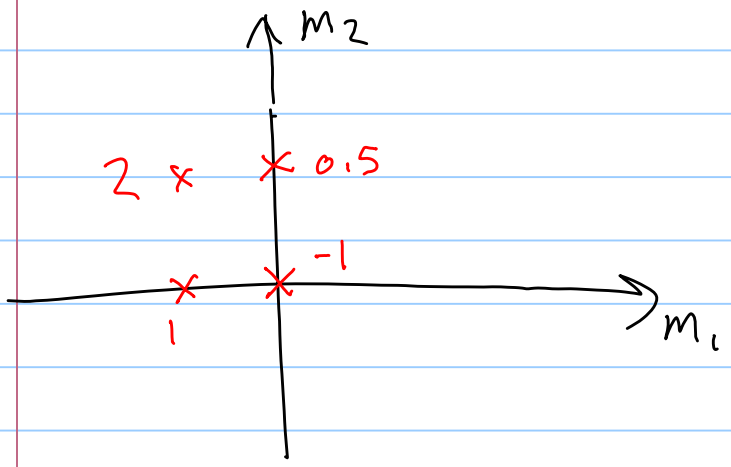
Example:



$h(n_1, n_2)$



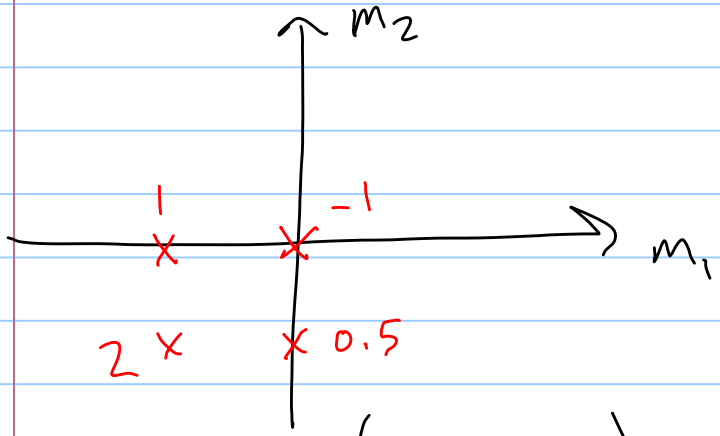
$x(n_1, n_2)$



Flip along horizontal axis first

$x(-m_1, m_2)$

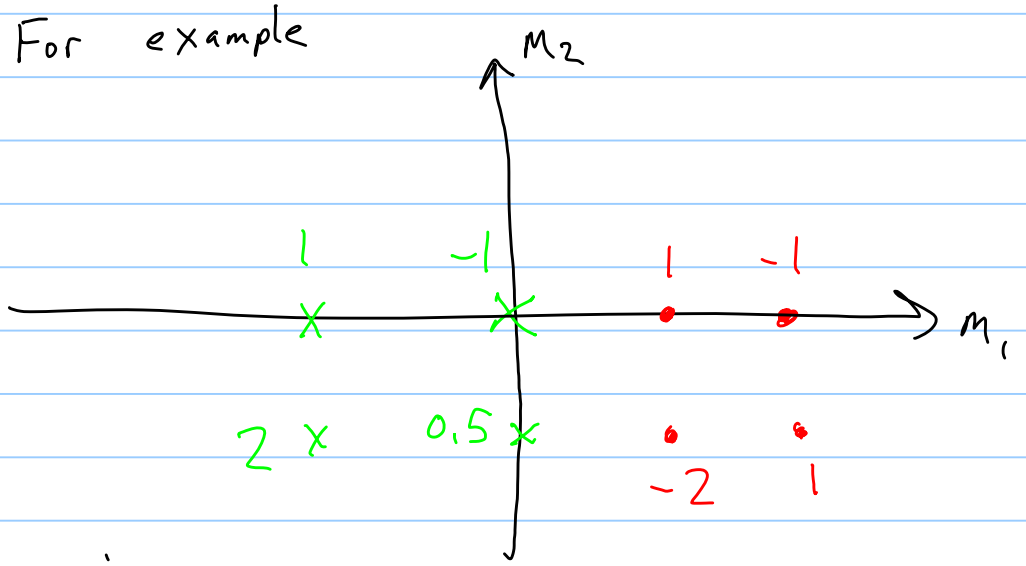
Now flip along vertical axis



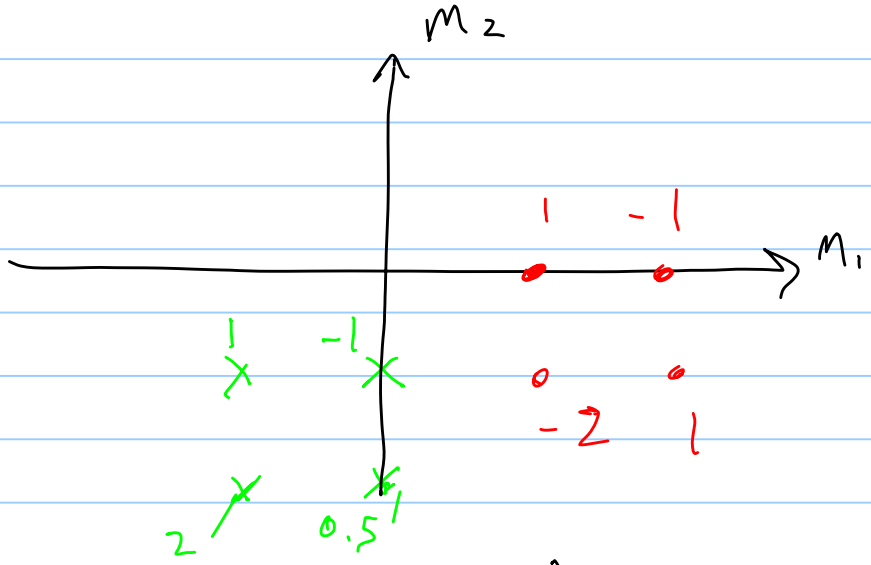
$x(-m_1, -m_2)$

Now we need to shift $x(-m_1, -m_2)$ with respect $h(+m_1, +m_2)$

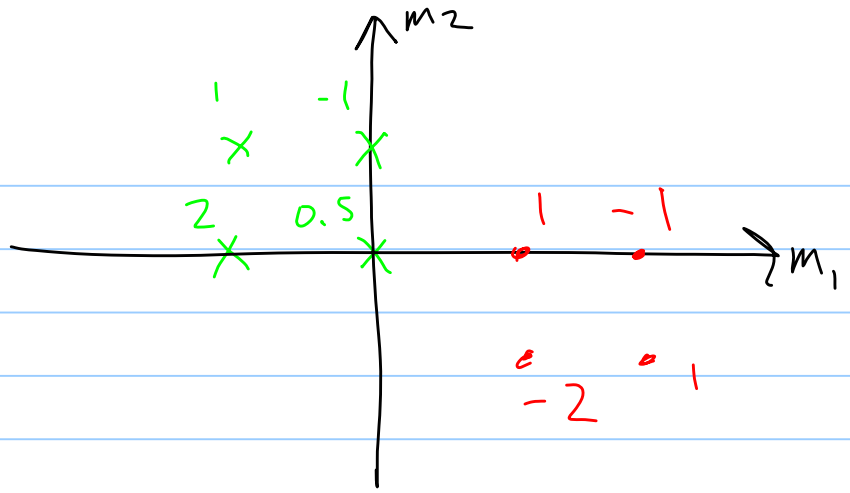
For example



$x(n_1 - m_1, n_2 - m_2)$ $n_1 = 0$ $n_2 = 0$



$x(n_1 - m_1, n_2 - m_2)$ $n_1 = 0$ $n_2 = -1$



$x(n_1 - m_1, n_2 - m_2)$ $\quad n_1 = 0 \quad n_2 = 1$

So overlap occurs only for

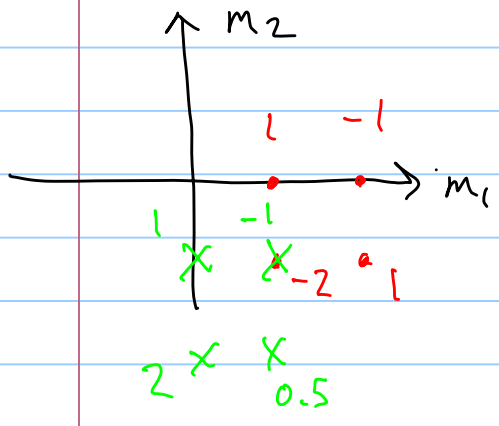
$n_1 = 1$ to 3

$n_2 = -1$ to $+1$

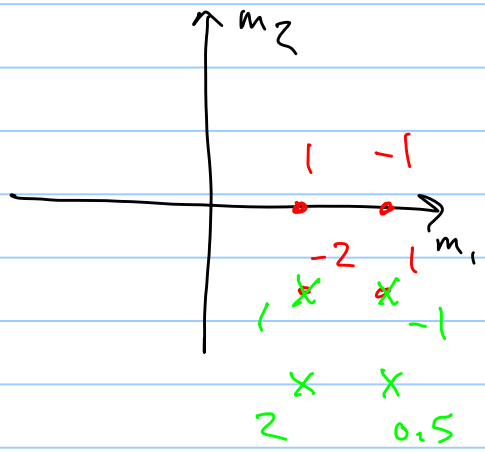
For $n_1 = 0 \quad n_2 = -1$ (that was 2nd picture)

slide to the right

$n_1 = 1, n_2 = -1$

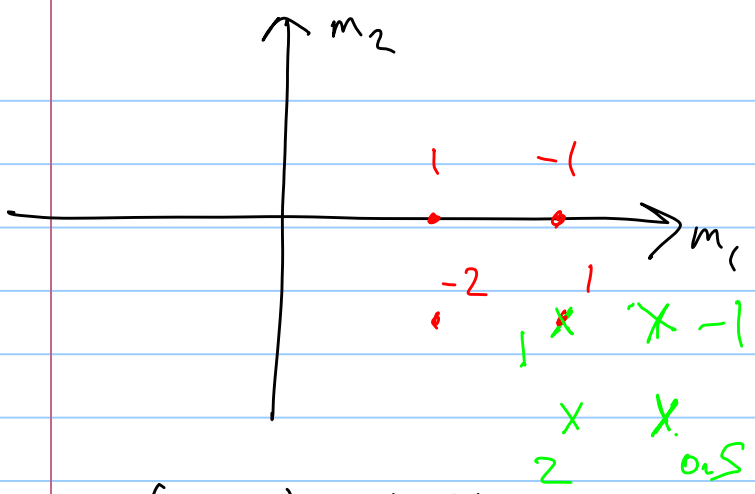


$n_1 = 2 \quad n_2 = -1$



$y(1, -1) = (-1)(-2) = 2$ $\qquad y(2, -1) = (1)(-2) + (1)(-1) = -3$

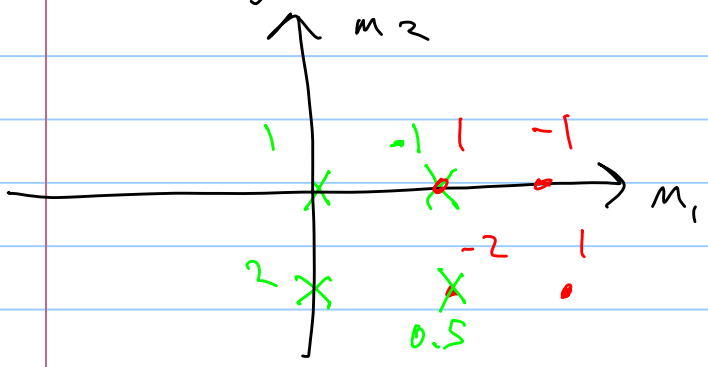
$n_1 = 3 \quad n_2 = -1$



$y(3,-1) = (1)(1) = 1$

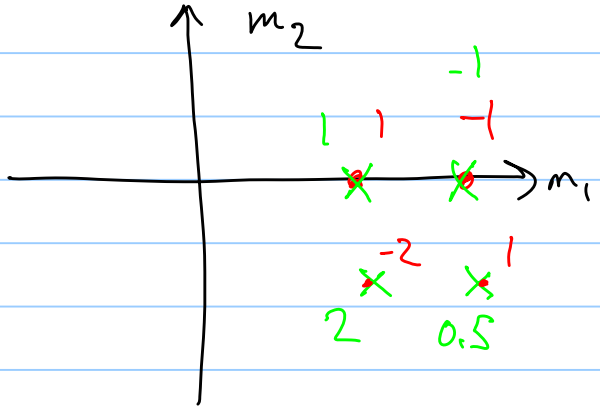
Now do

$n_1 = 1, \quad n_2 = 0$



$y(1,0) = (-1)(1) + (0.5)(-2)$
$= -2$

$n_1 = 2, \quad n_2 = 0$



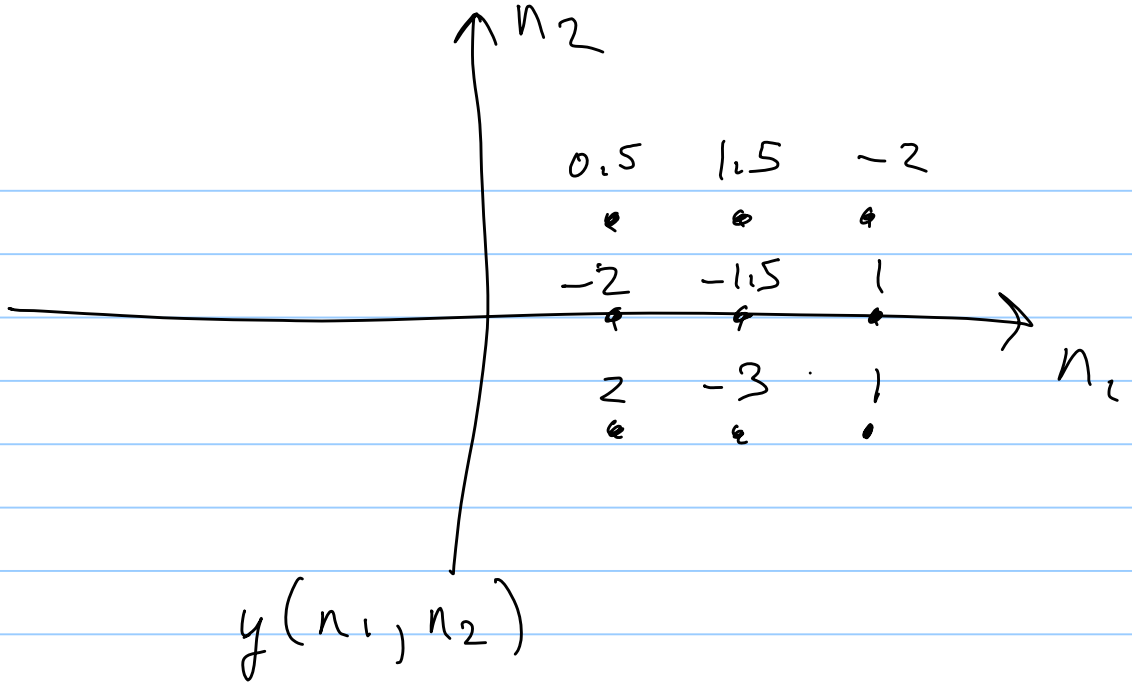
$y(2,0) = (1)(1) + (-1)(-1)$
$+ (2)(-2) + (0.5)(1)$
$= -1.5$

$y(3,0) = (1)(-1) + (2)(1) = 1$

$y(1,1) = (0.5)(1) = 0.5$

$y(2,1) = (2)(1) + (0.5)(-1) = 1.5$

$y(3,1) = (2)(-1) = -2$



Computational Considerations

2-D separable data convolution

Assume $x(n_1, n_2)$ is $N \times N$ matrix
$h(n_1, n_2)$ is $M \times M$ matrix

result of our 2-D convolution is

$y(n_1, n_2)$ is $(N+M-1) \times (N+M-1)$