

input
 $x_1 \ x_2$
1 0
0 1
-1 0
-1 1
0 -1

Desired
Label
1
1
0
0
0

Learning Rate = $\eta = 1$
Threshold = 0

$w_0 = -0.7$
 $w_1 = -0.2$
 $w_2 = 0.95$

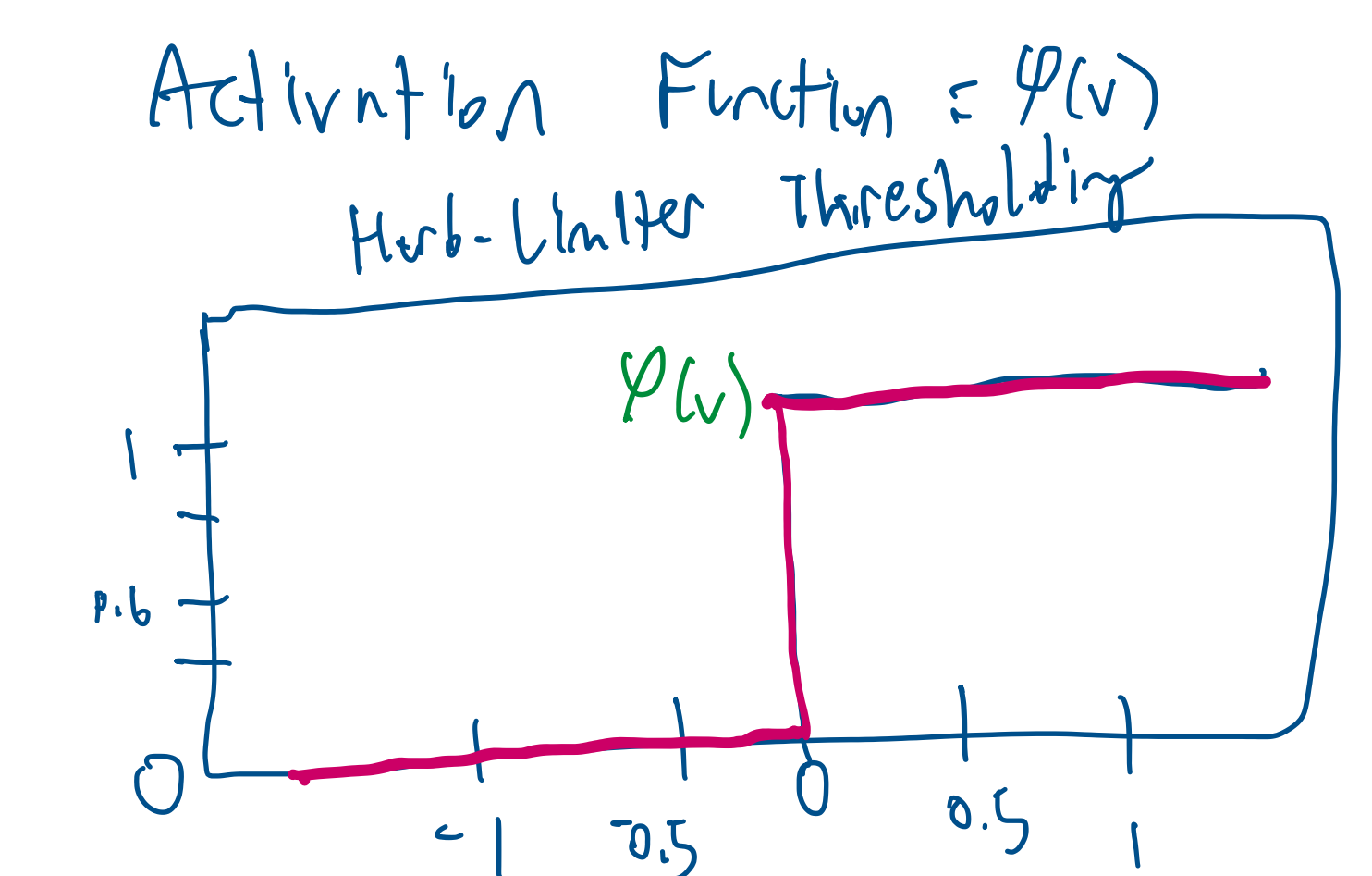
$x_1 \rightarrow$
 $x_2 \rightarrow$

Summing
Function
 Σ
Local
Field
 $v = w_0 x_0 + w_1 x_1 + w_2 x_2$

Thresholding
 $\phi(.)$
 $y = \phi(v)$
 $y = \begin{cases} 1 & \text{if } v \geq 0 \\ 0 & \text{if } v < 0 \end{cases}$
 $x_0 = 1$
 $bias = -0.7 = w_0$

Input:
 $x_i = x_1, \dots, x_m$
 $V = \sum_{j=0}^m w_j x_j = \vec{w} \cdot \vec{x}$

$bias = 1 = x_0$



$(1,0) = -0.7(1) + -0.2(1) + .95(0) = -0.9 < 0 = 0$
 $(0,1) = -0.7(0) + -0.2(0) + .95(1) = 0.25 > 0 = 1$
 $(-1,0) = -0.7(1) + -0.2(-1) + .95(0) = -0.5 < 0 = 0$
 $(-1,1) = -0.7(1) + -0.2(-1) + .95(1) = 0.45 > 0 \neq 1$
 $(0,-1) = -0.7(0) + -0.2(0) + .95(-1) = -0.65 < 0 = 0$

input $x_1 \ x_2$	local field v	output (class) y_i	misclassified
1 0	-0.9	0	✓
0 1	0.25	1	
-1 0	-0.5	0	
-1 1	0.45	1	✓
0 -1	-1.65	0	

Update Weights
 $\Delta w = \eta (d_i - y_i) x_i$ Updated $w = w + \Delta w$
iteration 1 Learned weights

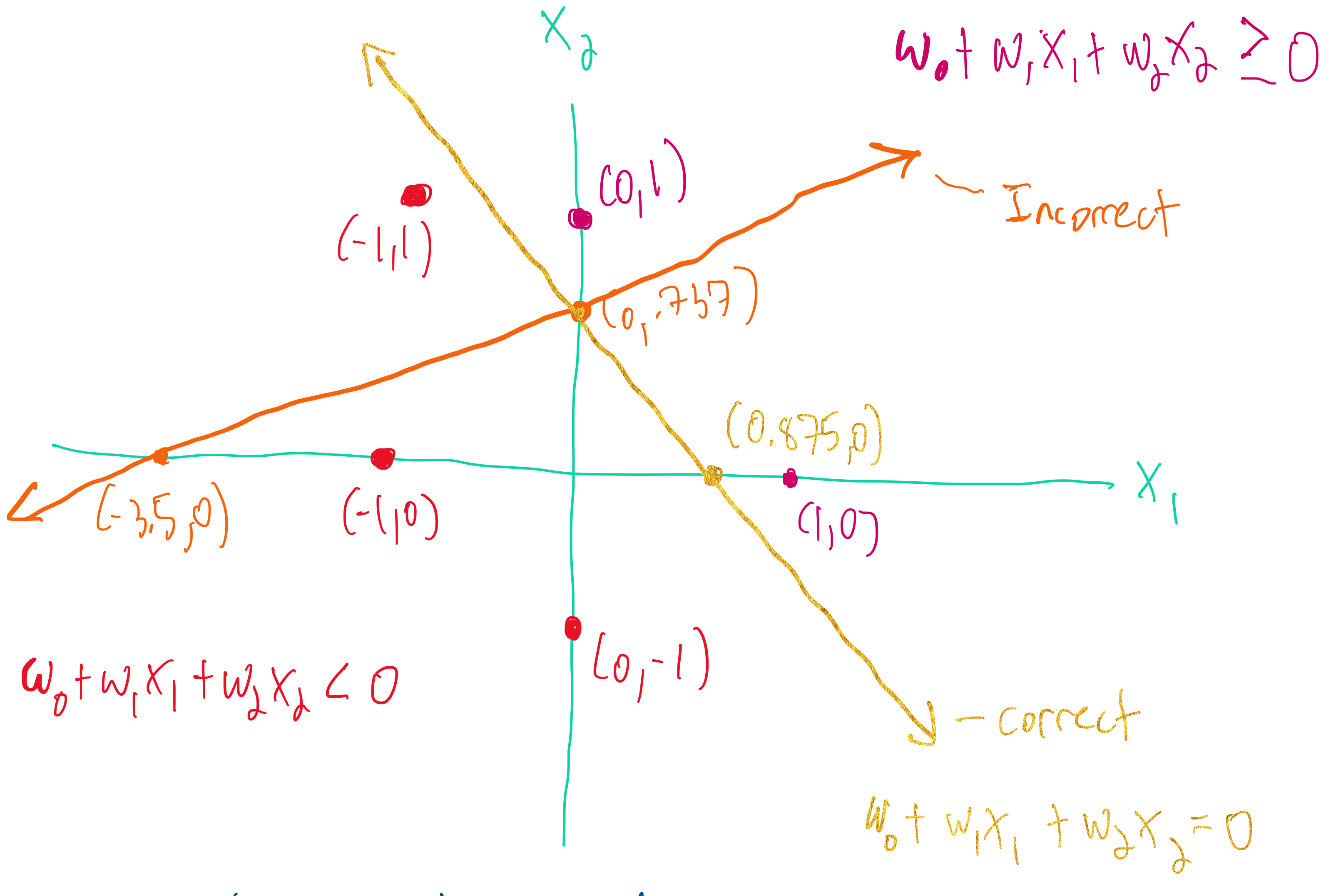
$\Delta w_1 = 1(1-0) = 1$ $w = -0.2 + 1 = 0.8$
 $\Delta w_2 = 1(1-0) = 0$ $w = 0.95 + 0 = 0.95$
 $(1,0) = -0.7(1) + 0.8(1) + 0.95(0) = 0.1 > 0 = 1$
 $(0,1) = -0.7 + 0.8(0) + 0.95(1) = 0.25 > 0 = 1$
 $(-1,0) = -0.7 + 0.8(-1) + 0.95(0) = -1.5 < 0 = 0$ ✓
 $(-1,1) = -0.7(1) + 0.8(-1) + 0.95(1) = -0.55 < 0 = 0$
 $(0,-1) = -0.7 + 0.8(0) + 0.95(-1) = -1.65 < 0 = 0$

INCORRECT CLASSIFIER

$w_1 x_1 + w_2 x_2 + w_0 = 0$
 $-0.2x_1 + 0.95(0) - 0.7 = 0$ $-0.2(0) + 0.95x_2 - 0.7 = 0$
 $-0.2x_1 = 0.7$ $-0.2 + 0.95x_2 = 0.7$
 $-0.2 \quad -0.2$ $+0.2 \quad -0.95$
 $x_1 = -3.5$ $x_2 = .737$

CORRECT CLASSIFIER

$0.8x_1 + 0.95(0) - 0.7 = 0$ $0.8(0) + 0.95x_2 - 0.7 = 0$
 $0.8x_1 = 0.7$ $0.95x_2 = 0.7$
 $0.8 \quad 0.8$ $.95 \quad 0.95$
 $x_1 = 0.875$ $x_2 = .737$



input $x_1 \ x_2$	desired label (d)	predict
2 2	1	1
-2 -2	0	0
0 0	0	0
-2 0	0	0

$(2,2) = -0.7 + 0.8(2) + 0.95(2) = 2.8 > 0 = 1$
 $(-2,-2) = -0.7 + 0.8(-2) + 0.95(-2) = -4.2 < 0 = 0$
 $(0,0) = -0.7 + 0.8(0) + 0.95(0) = -0.7 < 0 = 0$
 $(-2,0) = -0.7 + 0.8(-2) + 0.95(0) = -2.3 < 0 = 0$

	1	0	total
1	1	0	1
0	0	3	3

	1	0
1	TP	FN
0	FP	TN

$\frac{TP + TN}{TP + FN + FP + TN} = \text{Accuracy}$

$\frac{4}{4} = 1$

$v = w_0 x_0 + w_1 x_1 + w_2 x_2$
Decision Boundary
 $2y + 3x + 1 = 0$
 $y = \frac{-1 - 3x}{2}$
 $y = -0.5 - 1.5x$
if $x=0$ $y = -0.5$
if $y=0$,
 $0.5 = -1.5x$
 -1.5
 $-1/3 = x$