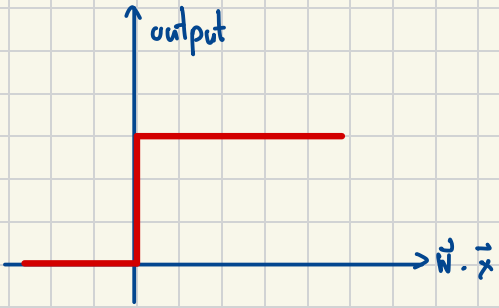
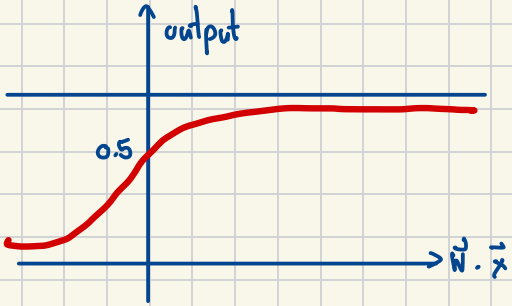
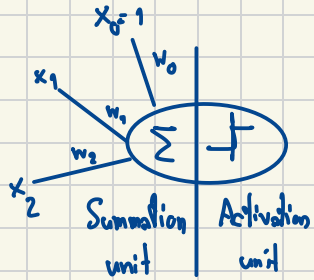
Activation function



if $\vec{w} \cdot \vec{x} > 0$:
    output = 1
else :
    output = 0 # -1

Sigmoid



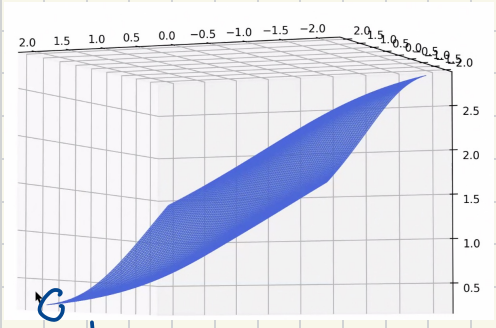


$$\sigma(\vec{w} \cdot \vec{x}) = \frac{1}{1 + e^{-\vec{w} \cdot \vec{x}}}$$

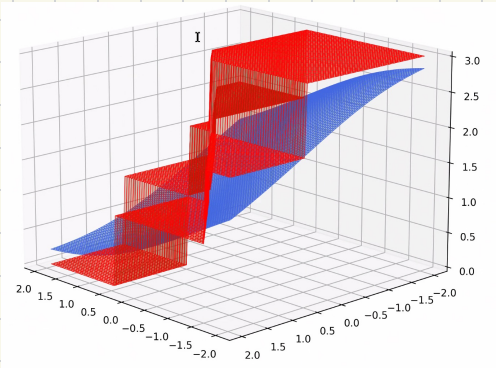
output อยู่ในช่วง [0, 1]

error = $(t - o)^2$

ใช้ abs ได้ แต่นำไป process ต่อยากกว่า ^ 2



E ต่ำสุด



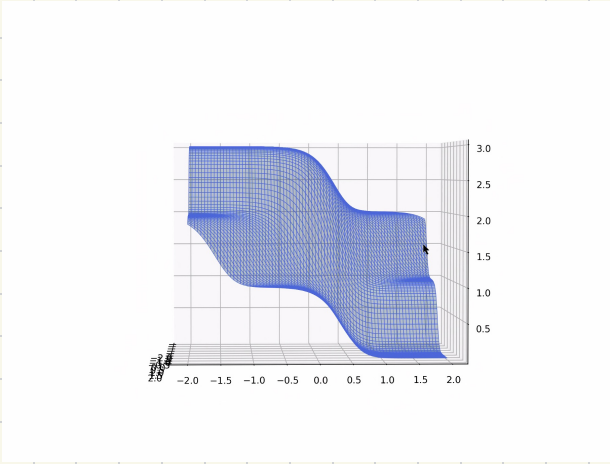
สีแดงคือ output > 0 ? 1 : 0

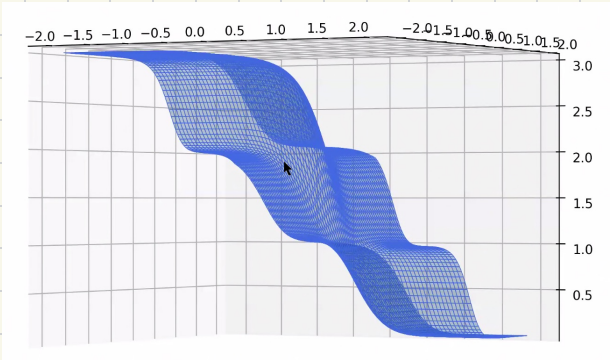
น้ำเงินคือ sigmoid

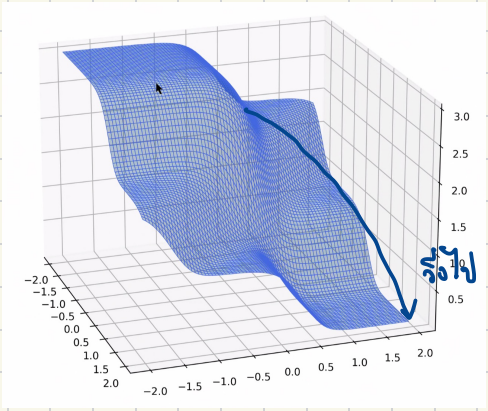
ถ้าเรา α คูณใน $\frac{1}{1+e^{-\alpha x}}$ ทำให้โค้งมากขึ้น

รกขึ้น

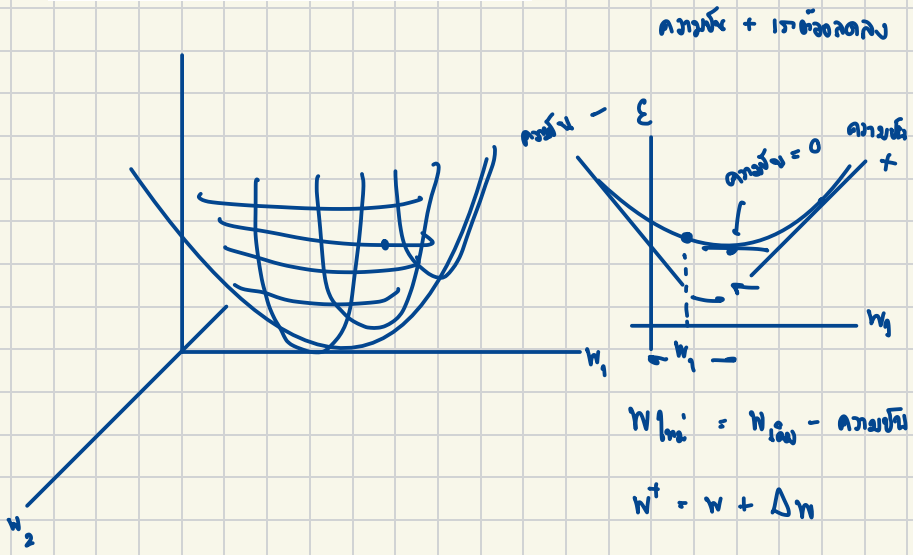
linear threshold วิ่งเหมือน sigmoid แต่ต่างตอน training







วิธีนี้ ε ต่ำสุด ใช้ Hill Climbing ได้



$w_{ใหม่} = w_{เดิม} - ความชัน$

$w^t = w + \Delta w$

$\Delta w = -ความชัน$

$$\frac{\partial error}{\partial \vec{w}} = \frac{\partial \frac{1}{2}(t-o)^2}{\partial \vec{w}}$$

$$= \frac{1}{2}\frac{\partial}{\partial \vec{w}}(t-o)^2$$

$$= \frac{1}{2}\cancel{2}(t-o)\frac{\partial (t-o)}{\partial \vec{w}}$$

$$= (t-o)\frac{\partial -o}{\partial w}$$

Nice property sigmoid

$$\frac{\partial \sigma(y)}{\partial y} = \sigma(y)(1-\sigma(y))$$

$$= -(t-o)\,\frac{\partial \sigma}{\partial \vec{w}}$$

$$= -(t-o)\,\frac{\partial \sigma(\vec{w}\cdot\vec{x})}{\partial \vec{w}}$$

$o = \sigma(\vec{w}\cdot\vec{x})$

$$= -(t-o)\,\frac{\partial \sigma(\vec{w}\cdot\vec{x})}{\partial \vec{w}\cdot\vec{x}} \cdot \frac{\partial \vec{w}\cdot\vec{x}}{\partial \vec{w}}$$

$$= -(t-o)(\sigma(\vec{w}\cdot\vec{x}))(1-\sigma(\vec{w}\cdot\vec{x}))\cdot\vec{x}$$

ความชัน $= -(t-o)\,o\,(1-o)\,\vec{x}$

$$\vec{w} = \vec{w} + \Delta\vec{w}$$

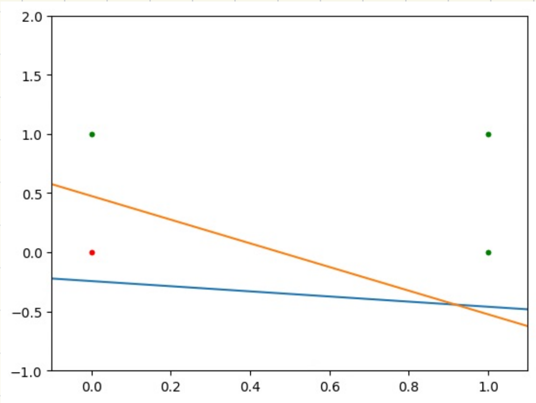
$$\Delta\vec{w} = -[-(t-o)\,o\,(1-o)\,\vec{x}]$$

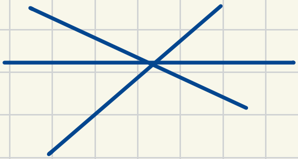
$$\Delta\vec{w} = \eta\,(t-o)(o)(1-o)\,\vec{x}$$

เราไม่บวกค่าความชันตรง ๆ

เราจะเอา η คูณ

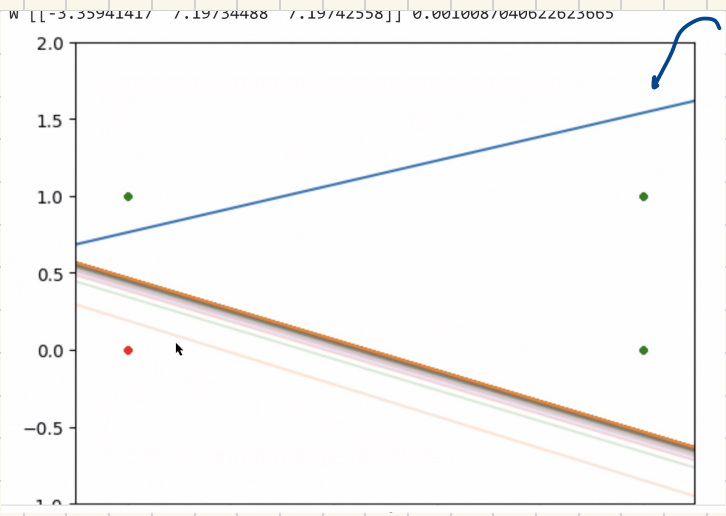
learning rate



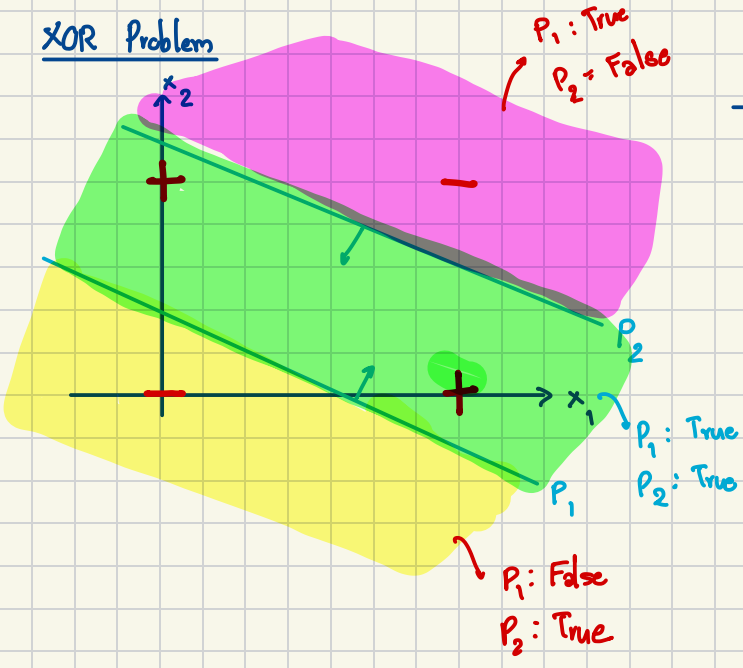


```
    W += eta*(Y[0][i]-o)*o*(1-o)*X[i]
    iter+=1
  if iter%10000==0:
    show_data(X,W,0.2)
    print('W',W,err)
show_data(X,W,1)
```

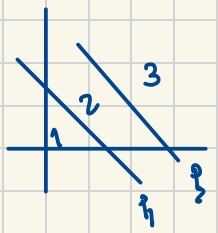
```
Initial W [[ 0.21748135 -0.45428729  0.01747177]]
W [[-1.97593452  4.49297452  4.49495432]] 0.012994855948110739
W [[-2.42423511  5.35914888  5.35982057]] 0.005856092164417706
W [[-2.67113932  5.84129678  5.84168254]] 0.0037182873783956965
W [[-2.84087643  6.1743052   6.17457255]] 0.002707801811447149
W [[-2.96989643  6.42812942  6.42833304]] 0.0021230022230300408
W [[-3.07380765  6.63293826  6.63310235]] 0.001743027102560759
W [[-3.16071135  6.80445947  6.80459672]] 0.0014768557869726123
W [[-3.235345    6.95191869  6.95203656]] 0.0012802852871488788
W [[-3.30071533  7.08118477  7.081288  ]] 0.001129313382323869
W [[-3.35884847  7.1962196   7.19631141]] 0.0010098038205038388
```

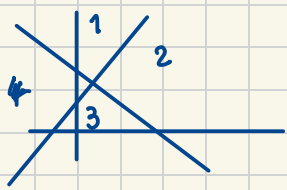


XOR Problem

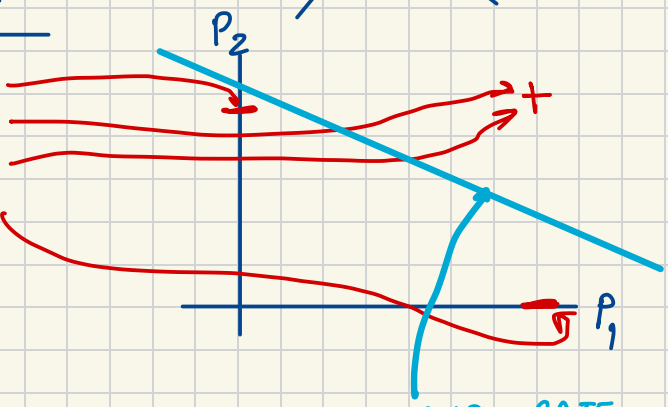


x_1	x_2	target	
0	0	0	−
0	1	1	+
1	0	1	+
1	1	0	−

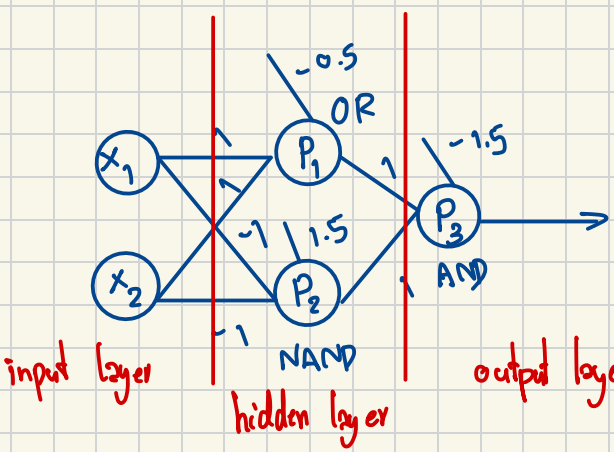


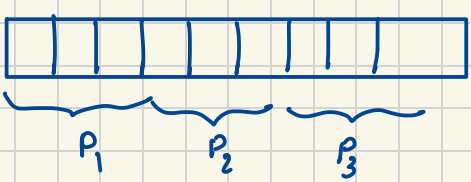


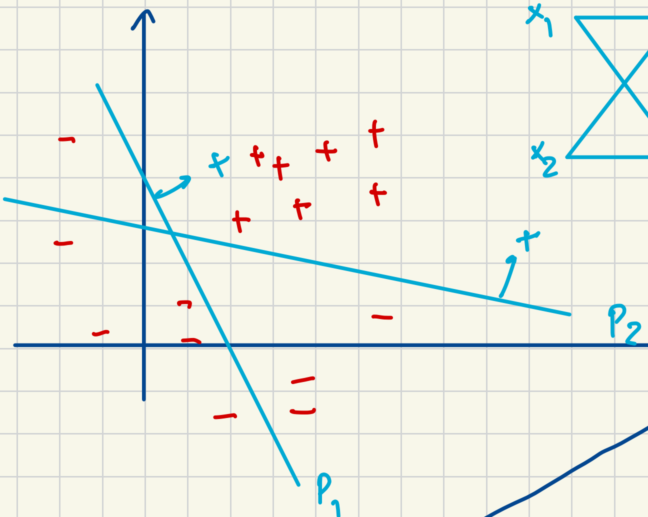
x_1	x_2	P_1	P_2	target
0	0	0	1	−
0	1	1	1	+
1	0	1	1	+
1	1	1	0	−

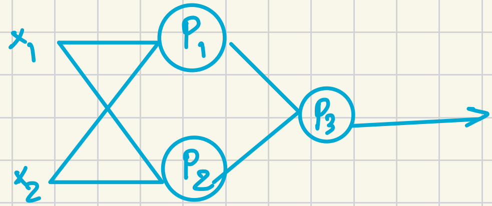


AND GATE









$1 - x_1 + x_2$ กับ $-1 + x_1 - x_2$

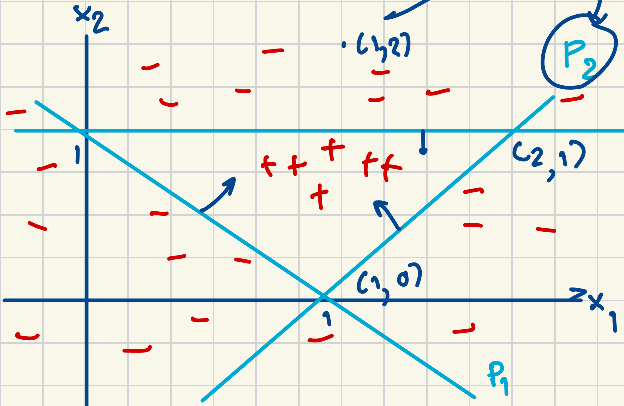
$x_1 = x_2$

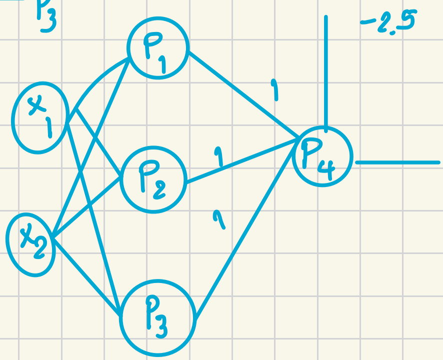
$x_1 - x_2 = 1$

$x_2 < 1$

$1 - x_2 > 0$

$\vec{w}_{P_3} = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$





$P_1 \quad x_1 + x_2 = 1 \qquad \vec{w} = \begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}$

ผม แก้