

# TLU treenimine

Ahti Peder

# Eesmärk

- ?
- Lähendamisülesanne → esialgne lahend → parim lahend
- Kaalude korrigeerimine. Milleks?

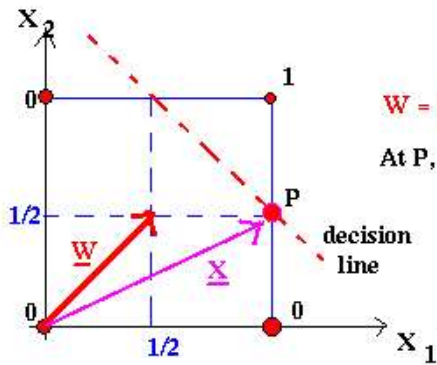
# Ülesande täpsustus

- Kui  $w \cdot x \geq \Theta$ , siis väljundisse “1”
- $w \cdot x + (-1) \cdot \Theta \geq 0$
- Lisame kaalude vektorile ühe dimensiooni  $\rightarrow$   
( $w_1, w_2, \dots, w_n, \Theta$ )
- $w \cdot x = 0$ , otsustuse hüpertasand
- Kõikidel sisenditel kuju  
( $x_1, x_2, -1$ )

$$\begin{array}{l} w \cdot x \geq 0 \quad \Rightarrow \quad y = 1 \\ w \cdot x < 0 \quad \Rightarrow \quad y = 0 \end{array}$$

# Näide

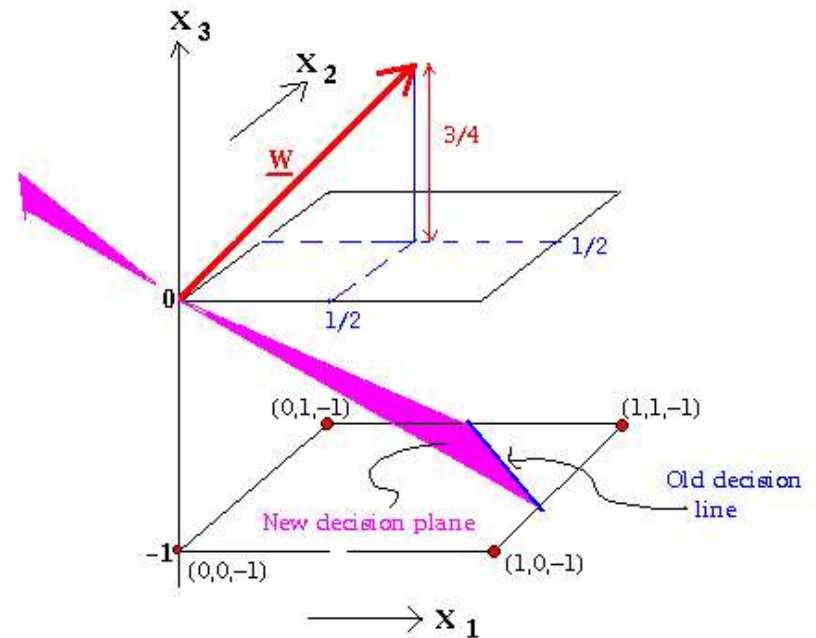
Kahe sisendiga TLU,  
Sisendiga (1,1) on väljund "1", "mujal" "0"  
 $w = (1/2; 1/2)$  ja  $\Theta = 3/4$



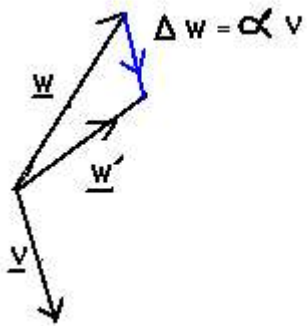
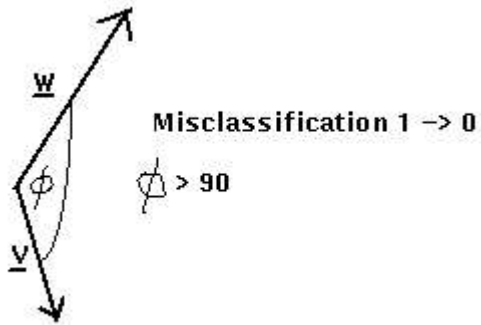
$$W = (0.5, 0.5) \quad X = (1, 0.5)$$

$$\text{At P, } \underline{W} \cdot \underline{X} = (0.5, 0.5) \cdot (1, 0.5) = 0.75$$

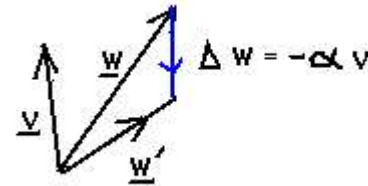
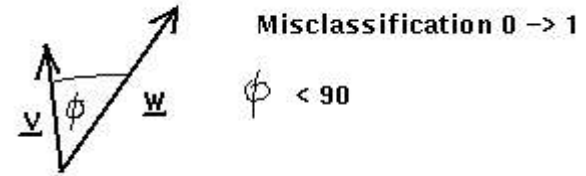
$$\text{therefore } \Theta = 0.75$$



# Kaalude vektori arvutamine



$$w' = w + \alpha v$$



$$w' = w - \alpha v$$

$$w' = w + \alpha(t - y)v$$

# Algoritm “parima” kaaludekomplekti leidmiseks

```
repeat
  for each training vector pair  $(\mathbf{v}, t)$ 
    evaluate the output  $y$  when  $\mathbf{v}$  is input to  $\mathbf{w}' = \mathbf{w} + \alpha(t - y)\mathbf{v}$ 
    if  $y \neq t$  then
      form a new weight vector  $\mathbf{w}'$  according to (??)
    else
      do nothing
    end if
  end for
until  $y = t$  for all vectors
```

# Pertseptroni koonduvusteoreem

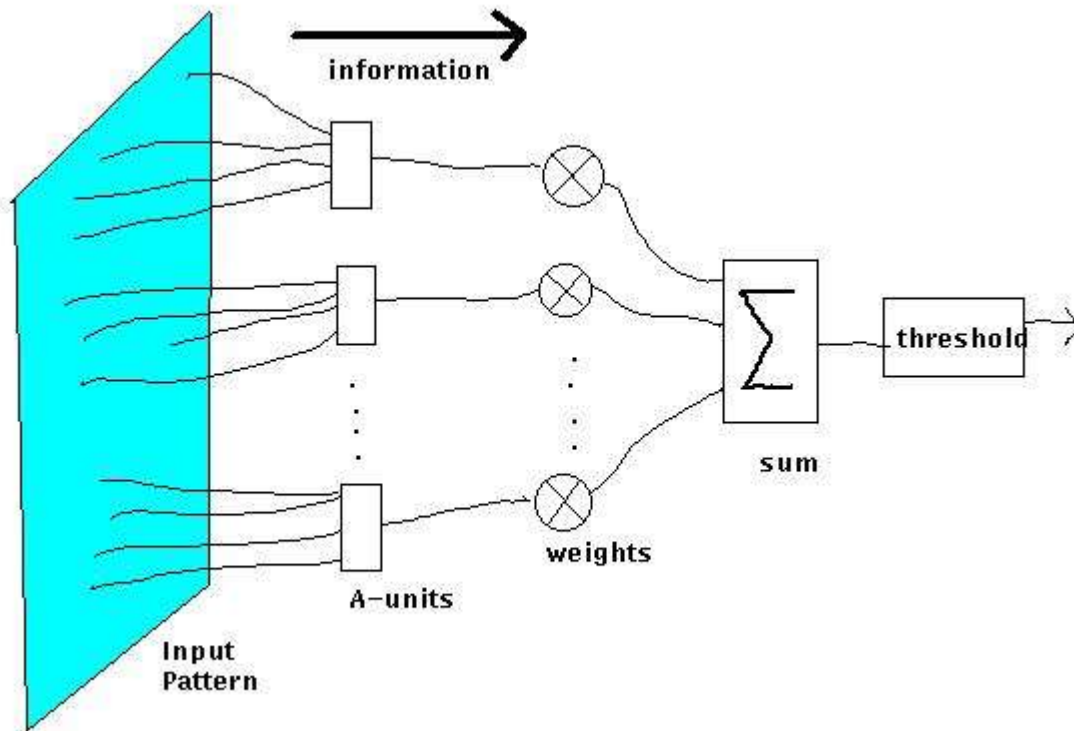
Kui vektorite klassid  $X$  ja  $Y$  on lineaarselt eralduvad, siis pertseptroni treeningalgoritmi rakendamine defineerib TLU, mille otsustuse hüperatasand eraldab  $X$  ja  $Y$

# Näide treeningust ☺

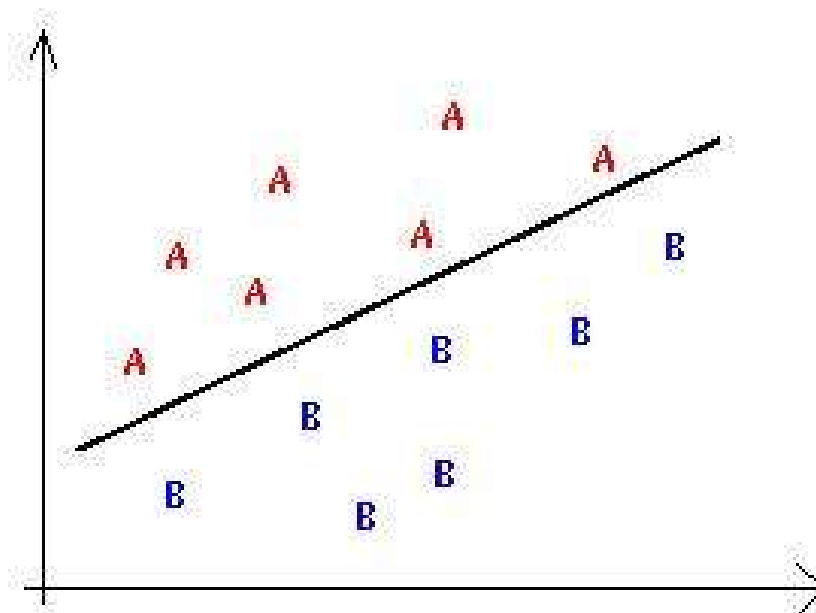
$w_1$	$w_2$	$\theta$	$x_1$	$x_2$	$a$	$y$	$t$	$\alpha(t - y)$	$\delta w_1$	$\delta w_2$	$\delta \theta$
0.0	0.4	0.3	0	0	0	0	0	0	0	0	0
0.0	0.4	0.3	0	1	0.4	1	0	-0.25	0	-0.25	0.25
0.0	0.15	0.55	1	0	0	0	0	0	0	0	0
0.0	0.15	0.55	1	1	0.15	0	1	0.25	0.25	0.25	-0.25
0.25	0.4	0.3	0	0	0	0	0	0	0	0	0
0.25	0.4	0.3	0	1	0.4	1	0	-0.25	0	-0.25	0.25
0.25	0.15	0.55	1	0	0.25	0	0	0	0	0	0
0.25	0.15	0.55	1	1	0.4	0	1	0.25	0.25	0.25	-0.25
0.5	0.4	0.3	0	0	0	0	0	0	0	0	0
0.5	0.4	0.3	0	1	0.4	1	0	-0.25	0	-0.25	0.25
0.5	0.15	0.55	1	0	0.5	0	0	0	0	0	0



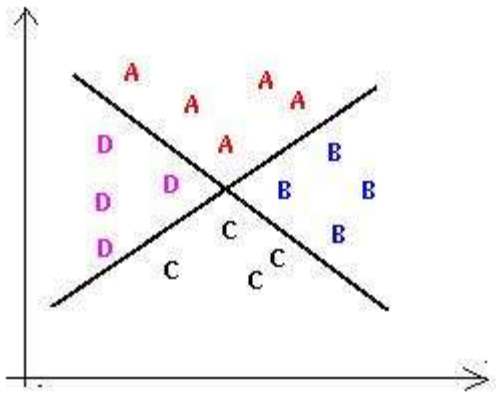
# Pertseptron



# Lineaarne eraldamine. Ühekihilised võrgud.



# Mittelinearselt eralduvad klassid. Mitmetasemelised võrgud



	1	0
$y_1$	(A B)	(C D)
$y_2$	(A D)	(B C)

