SVM DUALNI PROBLEM

$\omega_1 = \{ [0\ 0]^T, [-1\ 1]^T \}$
$\omega_2 = \{ [2\ 0]^T \}$

$$\boxed{\begin{array}{l} \min f(\vec{\lambda}) = \frac{1}{2} \vec{\lambda}^T Q \vec{\lambda} + \vec{c}^T \vec{\lambda} \\ \underline{\text{uz uvjet}} \\ A\vec{\lambda} \leq b,\ E\vec{\lambda} = d \end{array}}$$

SAMO IZRAČUNAJ Q, E, d, A, b, c I TO JE TO

MATLAB IZRAČUNA LAMBDE IZ TOGA, TJ. U ISPITU ĆEŠ DOBITI LAMBDE, NE TREBA IZVESTI KVADRATNO PROGRAMIRANJE

(E) LISTA DECIZIJSKIH OZNAKA, 1 ZA C_1, -1 ZA C_2

$E = [1\ \ 1\ \ -1]$

(b) SU SVE NULE TRANSPONIRANO (VERTIKALNO)

$b = [0\ \ 0\ \ 0]^T$ # ONOLKO NULA KOLKO IMA PRIMJERA

(A) $A = -I$

$$A = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

(d) d JE UVIJEK [0]

$d = [0]$

(c) c JE $[-1 \cdots -1]^T$, N ELEMENATA

$c = [-1\ \ -1\ \ -1]^T$

Q) OVDJE JEDINO IMA POSLA

$Q = d_i d_j \vec{x}_i^T \vec{x}_j$ # MATRICA NXN

NPR: $Q_{11} = 1 \cdot 1 \cdot [0\ 0] \cdot \begin{bmatrix} 0 \\ 0 \end{bmatrix} = 0$

$Q_{22} = 1 \cdot 1 \cdot [-1\ 1] \begin{bmatrix} -1 \\ 1 \end{bmatrix} = 2$

$Q_{12} = 1 \cdot 1 \cdot [0\ 0] \begin{bmatrix} -1 \\ 1 \end{bmatrix} = 0$

$$Q = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 2 & 2 \\ 0 & 2 & 4 \end{bmatrix}$$

ŠADA MATLAB NA TEMELJU TIH ULAZA U quadprog() FUNKCIJU IZRAČUNA $\vec{\lambda} = [0.5\ \ 0\ \ 0.5]^T$

- IZRAČUNA SE $\vec{w}$:

$$\vec{w} = \sum_{i=1}^{3} \lambda_i d_i \vec{x}_i = 0.5 \cdot 1 \cdot [0\ 0]^T + 0 \cdot 1 \cdot [-1\ 1]^T + 0.5 \cdot (-1) \cdot [2\ 0]^T = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$$

- RAČUNAMO b (ili w_3 TJ. ODMAK HIPERRAVNINE):
  - UZME SE JEDAN PRIMJER I KLASIFIKACIJOM NAMJESTI b

$\omega^T \vec{x}_i + b = \pm 1$

NPR $[-1\ 0] \begin{bmatrix} 0 \\ 0 \end{bmatrix} + b = \pm 1 \Rightarrow b = 1$ JER JE $d_1 = 1$

ILI $[-1\ 0] \begin{bmatrix} 2 \\ 0 \end{bmatrix} + b = \pm 1 \Rightarrow -2 + b = -1 \Rightarrow b = 1$

$d_3 = -1$

$$\tilde{\vec{w}} = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix} \Rightarrow -x_1 + 1 = 0$$

(4 boda) Za općeniti problem kvadratnog programiranja:

$$\min_x \frac{1}{2}\vec{x}^T Q\vec{x} + \vec{c}^T\vec{x}$$

uz uvjete

$$A\vec{x} \leq \vec{b}$$

$$E\vec{x} = \vec{d}$$

naći matrice Q, A i $E,$ te vektora c, b i d tako da rješenje gornjeg problema daje rješenje dualnog problema SVM za skup uzoraka

$$\omega_1 = \{[1,0]^T, [0,2]^T\}$$

$$\omega_2 = \{[2,1]^T, [2,3]^T\}$$

Pretpostavite da tražimo linearnu decizijsku funkciju. Ako smo kao rješenje problema dobili vektor $\left[\frac{8}{9}, \frac{2}{9}, \frac{10}{9}, 0\right]^T$ (*moguće je da brojevi nisu dobro prepisani*) , napišite jednadžbe granice između razreda.

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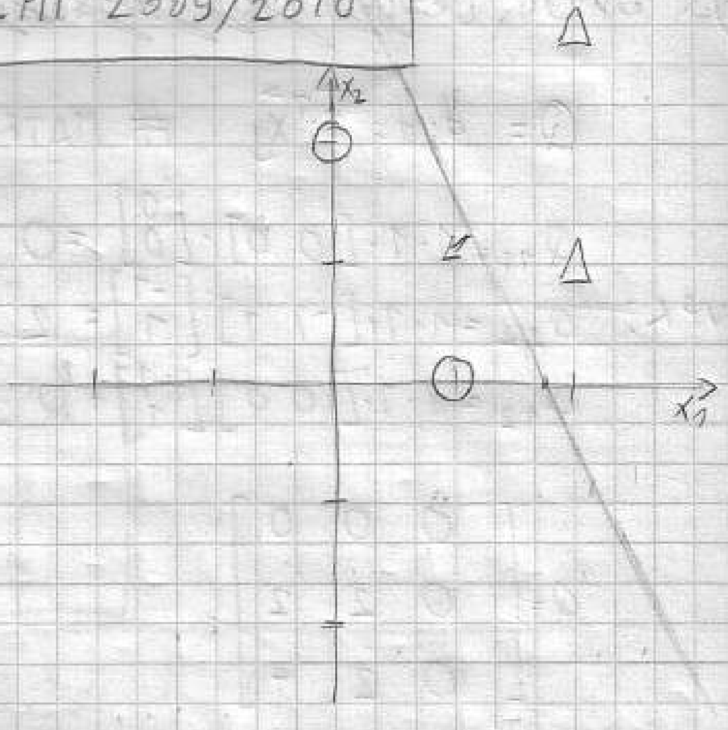

a)

$\omega_1 = \{[1\ 0]^T, [0\ 2]^T\}$ o

$\omega_2 = \{[2\ 1]^T, [2\ 3]^T\}$ Δ

$$E = [1\ 1\ -1\ -1]$$

$$b = [0\ 0\ 0\ 0]^T$$

$$A = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$

$$d = [0]$$

$$c = [-1\ -1\ -1\ -1]^T$$

$$Q = \begin{bmatrix} 1 & 0 & -2 & -2 \\ 0 & 4 & -2 & -6 \\ -2 & -2 & 5 & 7 \\ -2 & -6 & 7 & 13 \end{bmatrix}$$

b)

$$\alpha = \left[\frac{8}{9}\ \frac{2}{9}\ \frac{10}{9}\ 0\right]^T$$

$$\vec{\omega} = \frac{8}{9}\cdot 1 \cdot \begin{bmatrix} 1 \\ 0 \end{bmatrix} + \frac{2}{9}\cdot 1 \cdot \begin{bmatrix} 0 \\ 2 \end{bmatrix} - \frac{10}{9}\cdot 1 \cdot \begin{bmatrix} 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 8/9 \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 4/9 \end{bmatrix} - \begin{bmatrix} 20/9 \\ 10/9 \end{bmatrix}$$

$$= \begin{bmatrix} -\frac{12}{9} \\ -\frac{6}{9} \end{bmatrix} = \begin{bmatrix} -\frac{4}{3} \\ -\frac{2}{3} \end{bmatrix}$$

$$\vec{w} \begin{bmatrix} 1 \\ 0 \end{bmatrix} + b = 1$$

$$-\frac{4}{3} + b = 1 \Rightarrow b = \frac{7}{3}$$

$$w = \begin{bmatrix} -\frac{4}{3} \\ -\frac{2}{3} \\ \frac{7}{3} \end{bmatrix} \Rightarrow -\frac{4}{3}x_1 - \frac{2}{3}x_2 + \frac{7}{3} = 0 \quad / \cdot 3 = \boxed{-4x_1 - 2x_2 + 7 = 0}$$