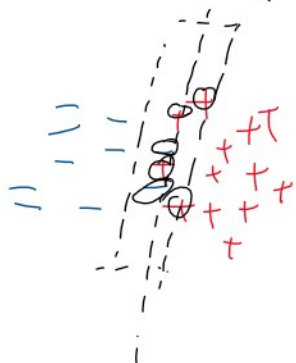


$$\Rightarrow \begin{aligned} \min & \quad ||w'||^2 \\ \text{s.t.} & \quad \forall_i y_i (\underbrace{\langle w', x_i \rangle + w_0}_{f(x, w)}) \geq 1 \end{aligned}$$



$$\begin{aligned} \min_w & \quad ||w'||^2 + \sum_i \epsilon_i \\ \text{s.t.} & \quad \forall_i y_i (\underbrace{\langle w', x_i \rangle + w_0}_{f(x, w)}) + \underbrace{\epsilon_i}_{\geq 0} \geq 1 \end{aligned}$$

all Cvx opt. are global opt.

$$\begin{aligned} l(\lambda, \lambda') &:= \min_{w, \epsilon} \left[||w'||^2 + \sum_i \epsilon_i - \sum_i \lambda_i y_i (\langle w', x_i \rangle + w_0) + \sum_i \lambda_i \epsilon_i - \lambda_i \right] \\ &= \max_{\substack{\lambda, \lambda' \\ \lambda \geq 0 \\ \lambda' \geq 0}} l(\lambda, \lambda') \end{aligned}$$

$$\begin{aligned} \sum w' &= \sum \lambda_i y_i x_i \\ \left\{ \begin{aligned} w' &= \frac{\sum \lambda_i y_i x_i}{2} \\ 1 &= \lambda_i + \lambda'_i \\ \sum \lambda_i y_i &= 0 \end{aligned} \right. \end{aligned}$$

$$(1) \quad ||w'||^2 = \frac{||\sum \lambda_i y_i x_i||^2}{4}$$

$$(2) \quad - \sum_i \lambda_i y_i \langle w', x_i \rangle = - \frac{\langle \sum \lambda_i y_i x_i, \sum \lambda_i y_i x_i \rangle}{2}$$

$$(1) + (2) = - \frac{\langle \sum \lambda_i y_i x_i, \sum \lambda_i y_i x_i \rangle}{2}$$

$$\begin{aligned} (1)+(2) &= - \frac{\sum_i \lambda_i y_i x_i, \sum_i \lambda_i y_i x_i}{4} \\ &= - \frac{\tilde{\lambda}^T X^T X \tilde{\lambda}}{4}, \quad \tilde{\lambda} = [\lambda_1 y_1 \dots \lambda_n y_n] \end{aligned}$$

$$\begin{aligned} (3) \quad \sum_i \epsilon_i - \sum_i \lambda_i \epsilon_i - \sum_i \lambda'_i \epsilon_i \\ = \sum_i \epsilon_i (1 - \lambda_i - \lambda'_i) = 0 \end{aligned}$$

$$(4) \quad - \sum_i \lambda_i y_i w_0 = -w_0 \sum_i \lambda_i y_i = 0$$

$$(5) \quad \sum_i \lambda_i$$

$$(1)+(2)+(3)+(4)+(5) = - \frac{\tilde{\lambda}^T X^T X \tilde{\lambda}}{4} + \sum_i \lambda_i$$

$$\begin{cases} \max_{\lambda, \lambda'} - \frac{\tilde{\lambda}^T X^T X \tilde{\lambda}}{4} + \sum_i \lambda_i \\ \text{s.t. } \lambda_i \geq 0, \lambda'_i \geq 0 \\ \lambda_i + \lambda'_i = 1 \\ \sum_i \lambda_i y_i = 0 \end{cases} \quad \begin{cases} \lambda'_i \geq 0 \\ \lambda_i + \lambda'_i = 1 \end{cases}$$

$$\Rightarrow 0 \leq \lambda_i \leq 1$$

$$\begin{cases} \max_{\lambda} - \frac{\tilde{\lambda}^T X^T X \tilde{\lambda}}{4} + \sum_i \lambda_i \\ \text{s.t. } \lambda_i \in [0, 1], \sum_i \lambda_i y_i = 0 \end{cases} \Rightarrow \lambda_i$$

$$K := X^T X \in \mathbb{R}^{n \times n}$$

$$K_{ij} = \langle x_i, x_j \rangle$$

$$\Rightarrow \underline{k(x_i, x_j)}$$

SM-SVM

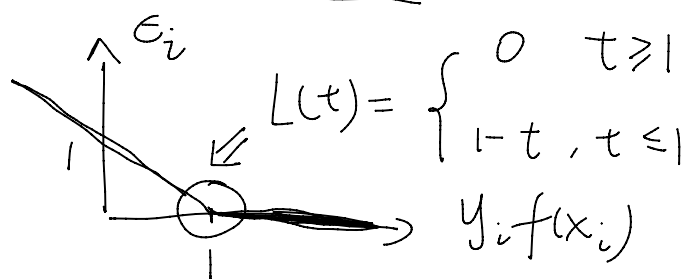
$$\min \|w'\|^2 + \sum_i \epsilon_i$$

$$\text{s.t. } y_i f(x_i, w) + \epsilon_i \geq 1 \quad \forall_i$$

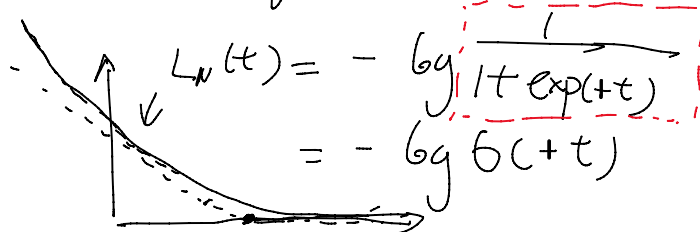
$$\epsilon_i \geq 0$$

$$\text{if } y \cdot f(x, w) \geq 1 \Rightarrow \epsilon_i = 0$$

$$\text{if } y \cdot f(x, w) \leq 1 \Rightarrow \epsilon_i = 1 - y f(x)$$



$$\min_w \|w'\|^2 + \sum_i L(y_i f(x_i))$$

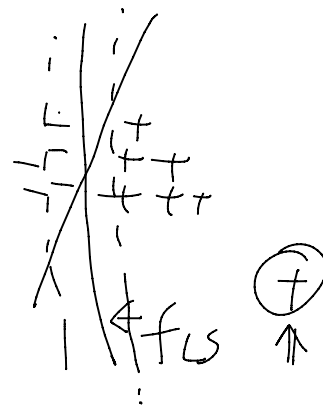


$$\min_w \|w'\|^2 - \sum_i \log \sigma(y_i f(x_i))$$

$$\max_w -\|w'\|^2 + \sum_i \log \sigma(y_i f(x_i))$$

reg

logit



(HW) $\min_w \sum_i (y_i - f(x_i, w))^2$

$$\text{s.t. } \|w'\|^2 \leq C$$

express \hat{w} using λ, y_i, x_i

\hat{w} using λ, y_i, x_i