$$\min \frac{1}{2}\|w\|^2 + C \cdot \sum_{n=1}^{N} \xi_n$$

$$\text{s.t.} \quad \forall_n \ \forall_{\bar{y} \neq y_n} \ \langle w, \Phi(x_n, y_n) - \Phi(x_n, \bar{y}) \rangle \geq 1 - \xi_n$$

$$\forall_n \quad \xi_n \geq 0$$

Lagrange multiplier

Lagrange multiplier

$$\Rightarrow L_p(w, \xi) = \frac{1}{2}\|w\|^2 + C \sum_{n=1}^{N} \xi_n - \sum_{n=1}^{N} \beta_n \xi_n - \sum_{n=1}^{N} \sum_{\bar{y} \neq y_n} \alpha_{n\bar{y}} \left(\langle w, \Phi(x_n, y_n) - \Phi(x_n, \bar{y}) \rangle \boxed{-1} + \xi_n \right)$$

$$\frac{\partial L}{\partial \xi_n} = C - \sum_{\bar{y} \neq y_n} \alpha_{n\bar{y}} - \beta_n \stackrel{!}{=} 0 \Rightarrow \forall_n \sum_{\bar{y} \neq y_n} \alpha_{n\bar{y}} \leq C$$

$$\frac{\partial L}{\partial w} = w - \sum_{n=1}^{N} \sum_{\bar{y} \neq y_n} \alpha_{n\bar{y}} \left(\Phi(x_n, y_n) - \Phi(x_n, \bar{y}) \right) \stackrel{!}{=} 0$$

$$\Rightarrow w = \sum_{n=1}^{N} \sum_{\bar{y} \neq y_n} \alpha_{n\bar{y}} \left(\Phi(x_n, y_n) - \Phi(x_n, \bar{y}) \right)$$

$$\Rightarrow \max_{\alpha} \sum_{n=1}^{N} \sum_{\bar{y} \neq y_n} \alpha_{n\bar{y}} - \frac{1}{2} \sum_{\substack{n=1 \\ m=1}}^{N} \sum_{\substack{\bar{y} \neq y_n \\ \bar{\bar{y}} \neq y_m}} \alpha_{n\bar{y}} \alpha_{m\bar{\bar{y}}} \left(\Phi(x_n, y_n) - \Phi(x_n, \bar{y}) \right)^T \left(\Phi(x_m, y_m) - \Phi(x_m, \bar{\bar{y}}) \right)$$

$$\text{s.t. } 0 \leq \sum_{\bar{y}} \alpha_{n\bar{y}} \leq C$$

(Kernel)

Reg. Least Squares Reg. → Ridge Regression

Solution: $w = (XX^T + c \cdot \mathbb{1})^{-1} \ldots$

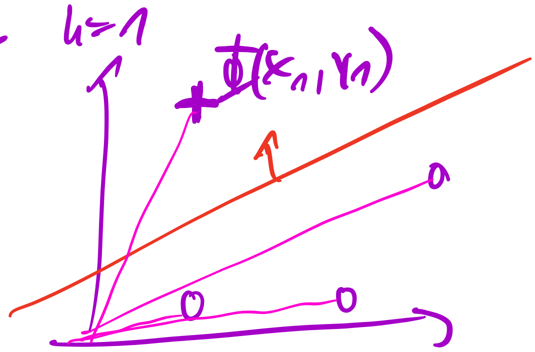
$$F(x,y) = \langle w^T, \Phi(x,y) \rangle$$

$$z(\bar{y}) \cdot \left(F(x_i,\bar{y}) + \theta_i \right) \geq \frac{1}{2}$$

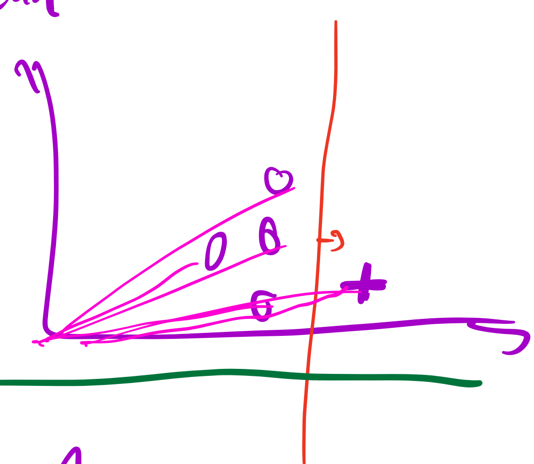
$$+1 \cdot F(x_i,y_i) + \cancel{\theta_i} \quad -1 \cdot F(x_i,\bar{y}) - \cancel{\theta_i} \geq \underbrace{\frac{1}{2} + \frac{1}{2}}_{1}$$

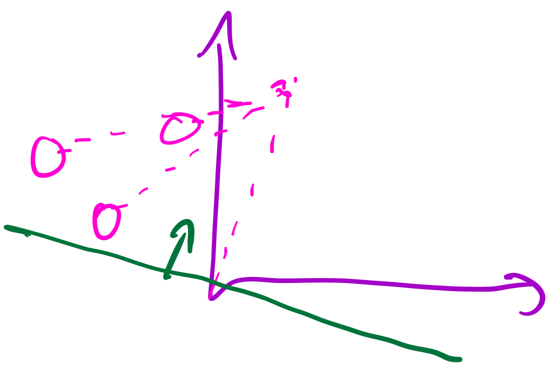
$z(y_i) = +1$ $\qquad$ $(z(\bar{y}) = -1)$

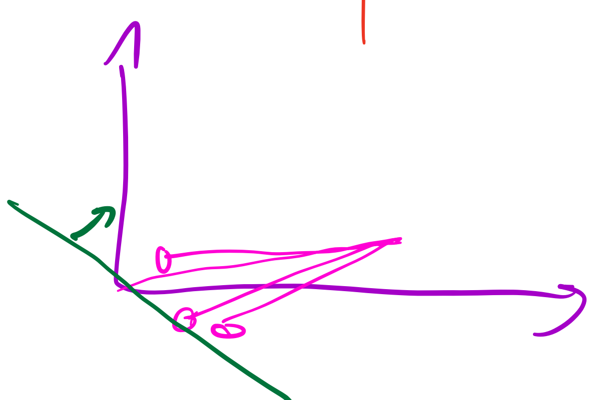
1st $\quad h=1$



2nd







$d(x,y)$

≥ 1

≥ 2

$(x_u, \text{"NVDN"})$

$(x_u, \text{"NNDN"}) \rightarrow \Delta = 1$

$(x_u, \text{"NNNN"}) \rightarrow \Delta = 2$