$h : \mathcal{X} \to \mathcal{Y}$

$\mathcal{X}$

$\mathcal{Y}$

$f :$

$\mathcal{X} \times$

$\mathcal{Y} \to$

$\mathcal{R}$

y

x

f

$y \in$

$\mathcal{Y}$

$h_{\mathbf{w}}(x) = {}_{y \in \mathcal{Y}}$

$f_{\mathbf{w}}(x, y)$

$f_{\mathbf{w}}$

$f_{\mathbf{w}} = \mathbf{w}^T \Phi(x, y)$

$\mathbf{w}$

$\Phi(x, y)$

x

y

Φ

$\Delta :$

$\mathcal{Y} \times$

$\mathcal{Y} \to$

R

$\Delta(y, y') \geq \ for \ y \neq y'$

$\Delta(y, y) = 0$

(x, y)

$$R_p^{\Delta} = \int_{\mathcal{X} \times \mathcal{Y}} \Delta(\mathbf{y}, f(\mathbf{x})) dP(\mathbf{x}, \mathbf{y})$$

P

(x_i, y_i)

$$R_s^{\Delta}(f) = \frac{1}{n} \sum_{i=1}^{n} \Delta(\mathbf{y}_i, f(\mathbf{x}_i))$$

$\forall i \in \{1, \cdots, n\}, \forall \mathbf{y} \in \mathcal{Y} \backslash \mathbf{y}_i : \langle \mathbf{w}, \Phi(\mathbf{x}_i, \mathbf{y}_i) - \Phi(\mathbf{x}_i, \mathbf{y}) \rangle \leq 0$

$\max_{\gamma, \mathbf{w}: \|\mathbf{w}\| = 1} \gamma \ s.t \ \forall i \in \{1, \cdots, n\}, \forall \mathbf{y} \in \mathcal{Y} \backslash \mathbf{y}_i : \langle \mathbf{w}, \delta\Phi(\mathbf{y}) \rangle \leq \gamma$

$\min_{\mathbf{w}} \frac{1}{2} \|\mathbf{w}\|^2 \ s.t \ \forall i \in \{1, \cdots, n\}, \forall \mathbf{y} \in \mathcal{Y} \backslash \mathbf{y}_i : \langle \mathbf{w}, \delta\Phi(\mathbf{y}) \rangle \leq 1$

$\min_{\mathbf{w}, \xi} \frac{1}{2} \|\mathbf{w}\|^2 + \frac{C}{n} \sum_{i=1}^{n} \xi_i \ s.t \ \forall i \in \{1, \cdots, n\}, \forall \mathbf{y} \in \mathcal{Y} \backslash \mathbf{y}_i : \langle \mathbf{w}, \delta\Phi(\mathbf{y}) \rangle \leq 1 - \xi_i, \xi_i \leq 0$

C

C

ξ

?

$\min_{\mathbf{w}, \xi} \frac{1}{2} \|\mathbf{w}\|^2 + \frac{C}{n} \sum_{i=1}^{n} \xi_i \ s.t \ \forall i \in \{1, \cdots, n\}, \forall \mathbf{y} \in \mathcal{Y} \backslash \mathbf{y}_i : \langle \mathbf{w}, \delta\Phi(\mathbf{y}) \rangle \leq 1 - \frac{\xi_i}{\Delta(\mathbf{y_i}, \mathbf{y})}$

$\min_{\mathbf{w}, \xi} \frac{1}{2} \|\mathbf{w}\|^2 + \frac{C}{n} \sum_{i=1}^{n} \xi_i \ s.t \ \forall i \in \{1, \cdots, n\}, \forall \mathbf{y} \in \mathcal{Y} \backslash \mathbf{y}_i : \langle \mathbf{w}, \delta\Phi(\mathbf{y}) \rangle \leq \Delta(\mathbf{y_i}, \mathbf{y}) - \xi_i$

$O(n|\mathcal{Y}|)$

?

?

n

$\min_{\mathbf{w}, \xi_i \geq 0} \frac{1}{2} \mathbf{w}^T \mathbf{w} + C\xi$

$\forall i \in$

$\{1, \cdots, n\}, \hat{y}_i \in$

$\mathcal{Y} :$

$\mathbf{w}^T [\Psi(x_i, y_i) -$

$\Psi(x_i, \hat{y}_i)] \geq$

$\Delta(y_i, \hat{y}_i) -$

ξ_i

$\min_{\mathbf{w}, \xi_i \geq 0} \frac{1}{2} \mathbf{w}^T \mathbf{w} +$

$\frac{C}{n} \sum_{i=1}^{n} \xi_i \ s.t. for$