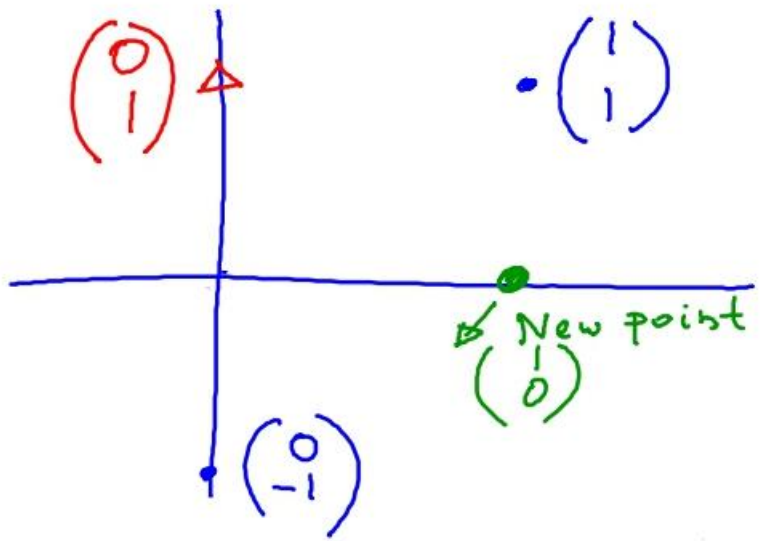


	t_i
$\underline{x}_1$	0 −1	1
$\underline{x}_2$	1 1	1
$\underline{x}_3$	0 1	−1

$t_i t_j (\underline{x}_i \cdot \underline{x}_j)$:

$t_1^2 (\underline{x}_1 \cdot \underline{x}_1) = 1 \qquad t_1 t_2 (\underline{x}_1 \cdot \underline{x}_2) = 1 \cdot 1 \cdot (-1) = -1$

$t_2^2 (\underline{x}_2 \cdot \underline{x}_2) = 2 \qquad t_2 t_3 (\underline{x}_2 \cdot \underline{x}_3) = -1$

$t_3^2 (\underline{x}_3 \cdot \underline{x}_3) = 1 \qquad t_3 t_1 (\underline{x}_3 \cdot \underline{x}_1) = 1$

$$\mathcal{L}_D = \lambda_1 + \lambda_2 + \lambda_3 - \frac{1}{2}\lambda_1^2 - \lambda_2^2 - \frac{1}{2}\lambda_3^2$$
$$+ \lambda_1\lambda_2 + \lambda_2\lambda_3 - \lambda_3\lambda_1$$

Constr: $\lambda_1 + \lambda_2 - \lambda_3 = 0 \Rightarrow \lambda_3 = \lambda_1 + \lambda_2$

$$L_D = 2\lambda_1 + 2\lambda_2 - 2\lambda_1^2 - \frac{1}{2}\lambda_2^2$$

Assume all patterns are support vectors.

$$\frac{\partial L_D}{\partial \lambda_1} = 0 \Rightarrow 2 - 4\lambda_1 = 0 \Rightarrow \boxed{\lambda_1 = \frac{1}{2}}$$

$$\frac{\partial L}{\partial \lambda_2} = 0 \Rightarrow 2 - \lambda_2 = 0 \Rightarrow \boxed{\lambda_2 = 2}$$

$$\lambda_3 = \lambda_1 + \lambda_2 \Rightarrow \boxed{\lambda_3 = \frac{5}{2}}$$

$$\underline{w} = \sum_i \lambda_i t_i \underline{x}_i \qquad \underline{w} \cdot \underline{x}_1 + w_0 = 1$$

$$\sum_i \lambda_i t_i (\underline{x}_1 \cdot \underline{x}_i) + w_0 = 1$$

$$\lambda_1 t_1 (\underline{x}_1 \cdot \underline{x}_1) + \lambda_2 t_2 (\underline{x}_1 \cdot \underline{x}_2) + \lambda_3 t_3 (\underline{x}_1 \cdot \underline{x}_3) + w_0 = 1$$

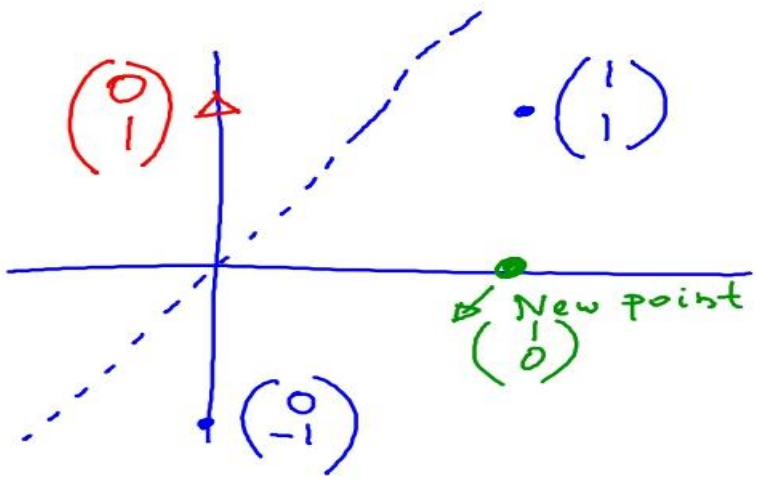
$$\frac{1}{2} - 2 + \frac{5}{2} + w_0 = 1 \Rightarrow \boxed{w_0 = 0}$$

New pattern: $x_{new} = \begin{bmatrix} x \\ y \end{bmatrix}$

$$\sum_i t_i \lambda_i (x_{new} \cdot x_i) + \cancel{w_0}^{0} = 0.$$

$$\Rightarrow \frac{1}{2}(x_{new} \cdot x_1) + 2(x_{new} \cdot x_2) - \frac{5}{2}(x_{new} \cdot x_3)$$

$$\Rightarrow -\frac{1}{2}Y + 2(X+Y) - \frac{5}{2}Y = 0 \Rightarrow \boxed{Y = 2X}$$



Classify $\begin{pmatrix} 1 \\ 0 \end{pmatrix} = \underline{x}_0$

$$y = t_1 \lambda_1 (\underline{x}_0 \cdot \underline{x}_1) + t_2 \lambda_2 (\underline{x}_0 \cdot \underline{x}_2) +$$
$$t_3 \lambda_3 (\underline{x}_0 \cdot \underline{x}_3) = 2 > 0 \Rightarrow \underline{\text{class 1.}}$$