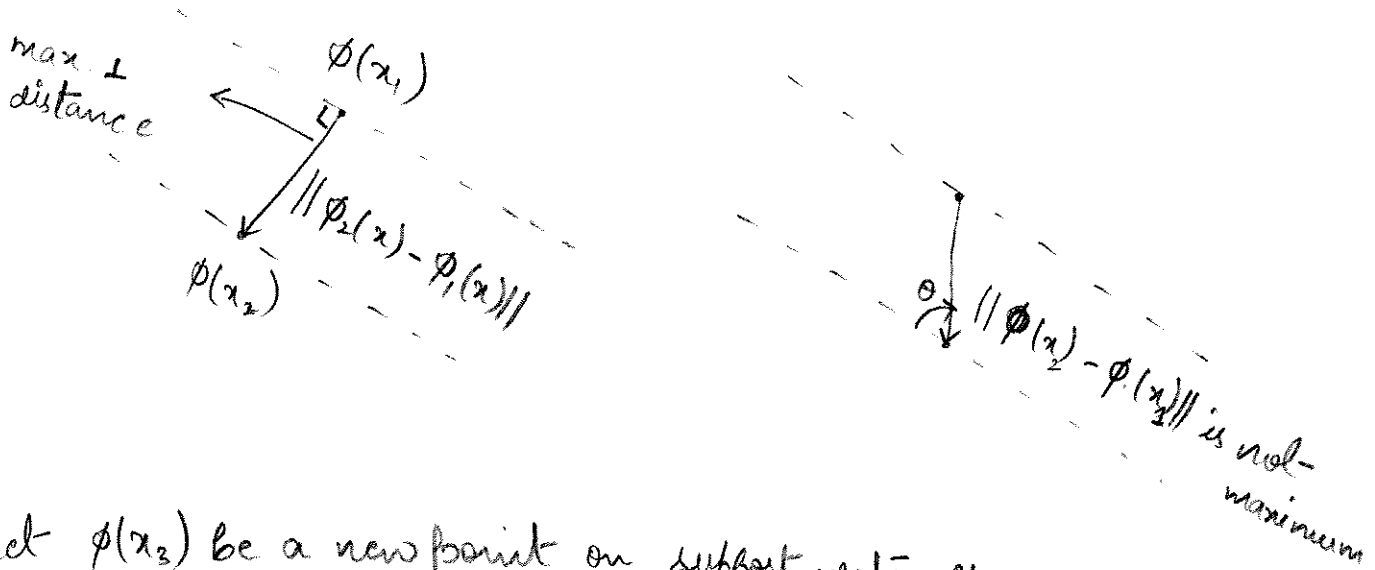
5.1 1) Given :- $x_1 = 0$, $y_1 = -1$, $x_2 = \sqrt{2}$, $y_2 = 1$ & $\phi(x_2) = (1, 2, 2)$

Also, $\phi(x_1) = (1, 0, 0)$

Now, we have only two points which are also the support vectors, so they have to be perpendicular for maximizing the distance.

∴ the maximum distance is $\| \phi(x_2) - \phi(x_1) \|$ which can be viewed as –



Let $\phi(x_3)$ be a new point on support vector plane of $\phi_2(x_2)$

$$\therefore \phi(x_3)\theta + b = 1 \quad \& \quad \phi(x_2)\theta + b = 1$$

——— (1) ——— (2)

Subtracting (2) from (1) –

$$[\phi(x_3) - \phi(x_2)]\theta = 0$$

Now, dot product of two vectors is zero which means

$$\vec{\theta} \perp [\phi(x_3) - \phi(x_2)]_{\text{vector}}$$

or $\vec{\theta}$ is $\parallel$ to $[\phi(x_2) - \phi(x_1)]$

$\therefore$ vector parallel to θ is $= \phi(x_2) - \phi(x_1)$

$$= (1, 2, 2) - (1, 0, 0)$$

$$= (0, 2, 2) \quad \underline{\text{Ans}}.$$