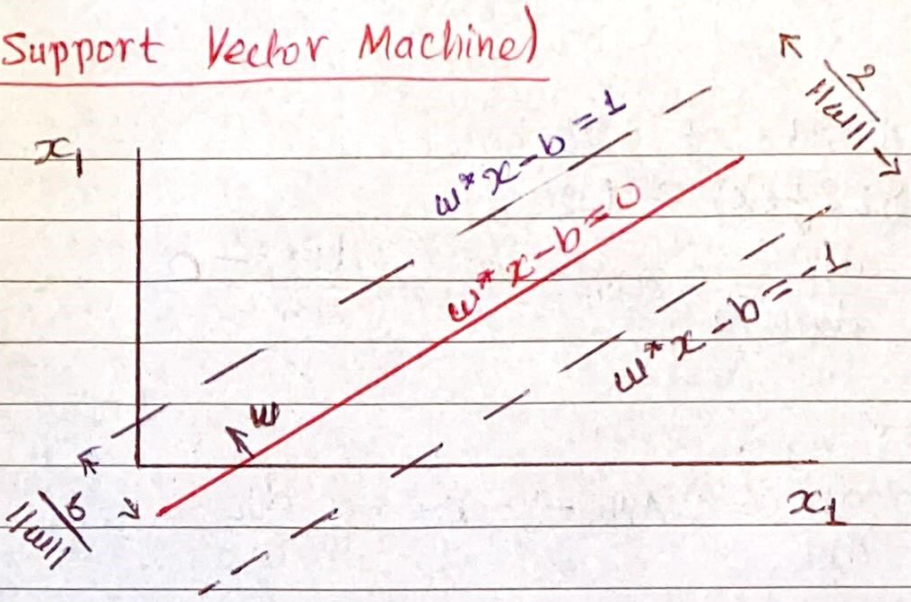
SVM (Support Vector Machine)



- Linear Model

$$w \cdot x - b = 0$$

- $w \cdot x_i - b \geq 1$ if $y_i = 1$
- $w \cdot x_i - b \leq -1$ if $y_i = -1$

$$y_i (w \cdot x_i - b) \geq 1$$

- Cost Function
  - Hinge Loss

$$J = \max(0, 1 - y_i (w \cdot x_i - b))$$

- $$J = \begin{cases} 0 & \text{if } y \cdot f(x) \geq 1 \\ 1 - y \cdot f(x) & \text{otherwise.} \end{cases}$$

- Add Regularization

$$J = \lambda \|w\|^2 + \frac{1}{n} \sum_{i=1}^{n} \max(0, 1 - y_i (w \cdot x_i - b))$$

If $y_i \cdot f(x) > 1$: $J_i = \lambda \|w\|^2$

else $J_i = \lambda \|w\|^2 + 1 - y_i (w \cdot x_i - b)$

- Gradients of cost function
  - If $y_i \cdot f(x) \geq 1$:

$$\frac{dJ_i}{dw_k} = 2\lambda w_k \quad \& \quad \frac{dJ_i}{db} = 0$$

  - else:

$$\frac{dJ_i}{dw_k} = 2\lambda w_k - y_i \cdot x_i \quad \& \quad \frac{dJ_i}{db} = y_i$$

- Update rule
  - For each training sample x_i:

$$w = w - \alpha \cdot dw$$
$$b = b - \alpha \cdot db$$