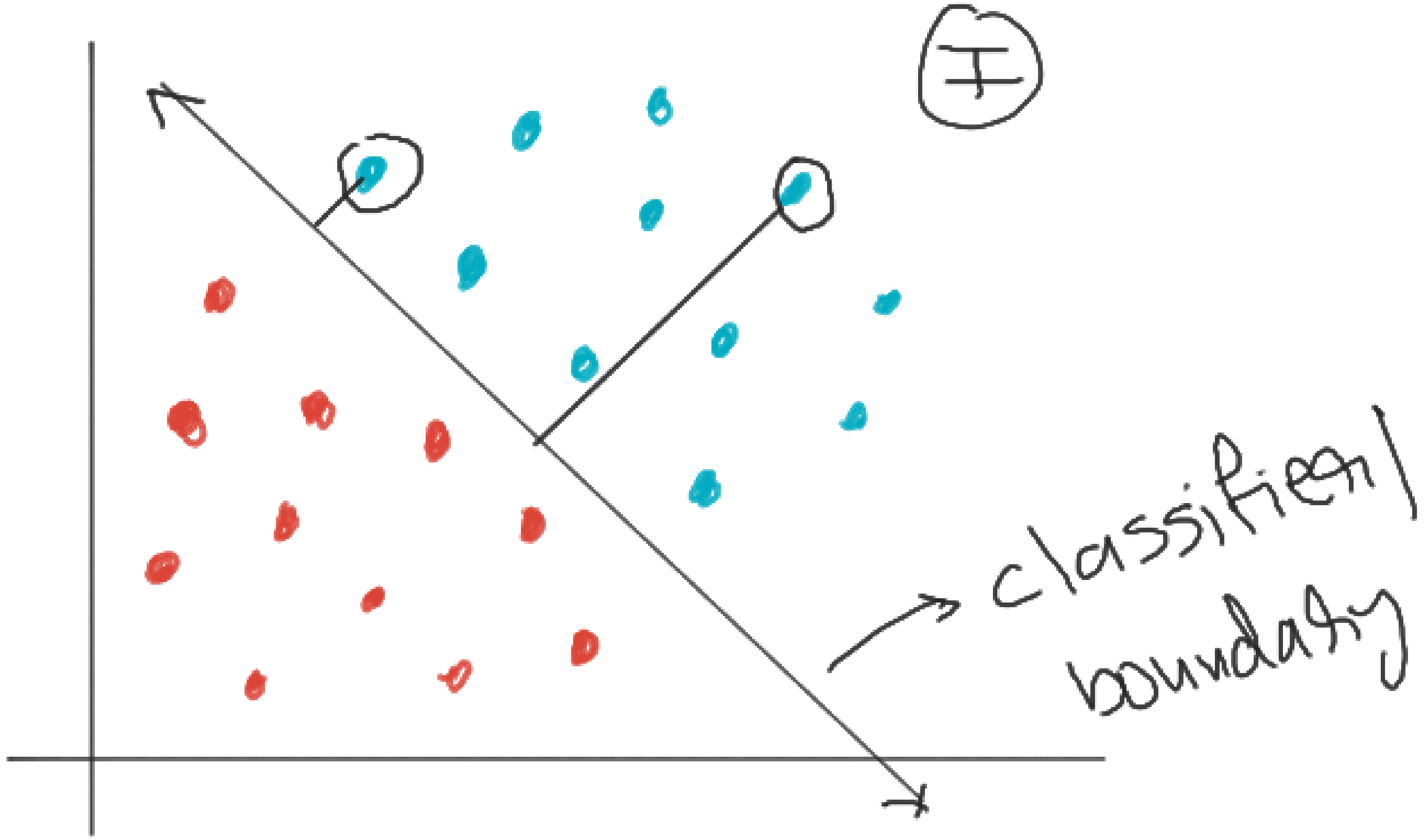
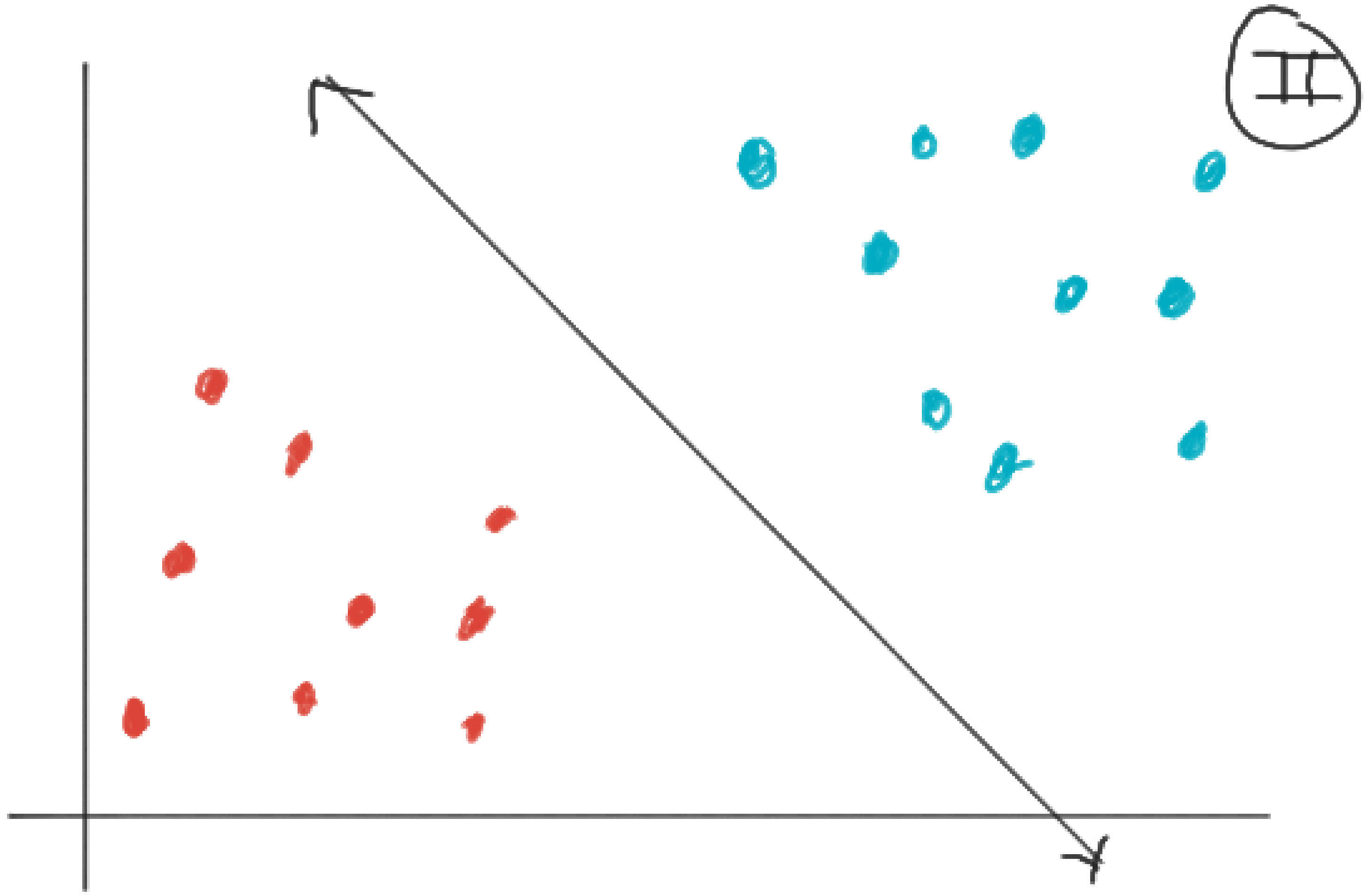


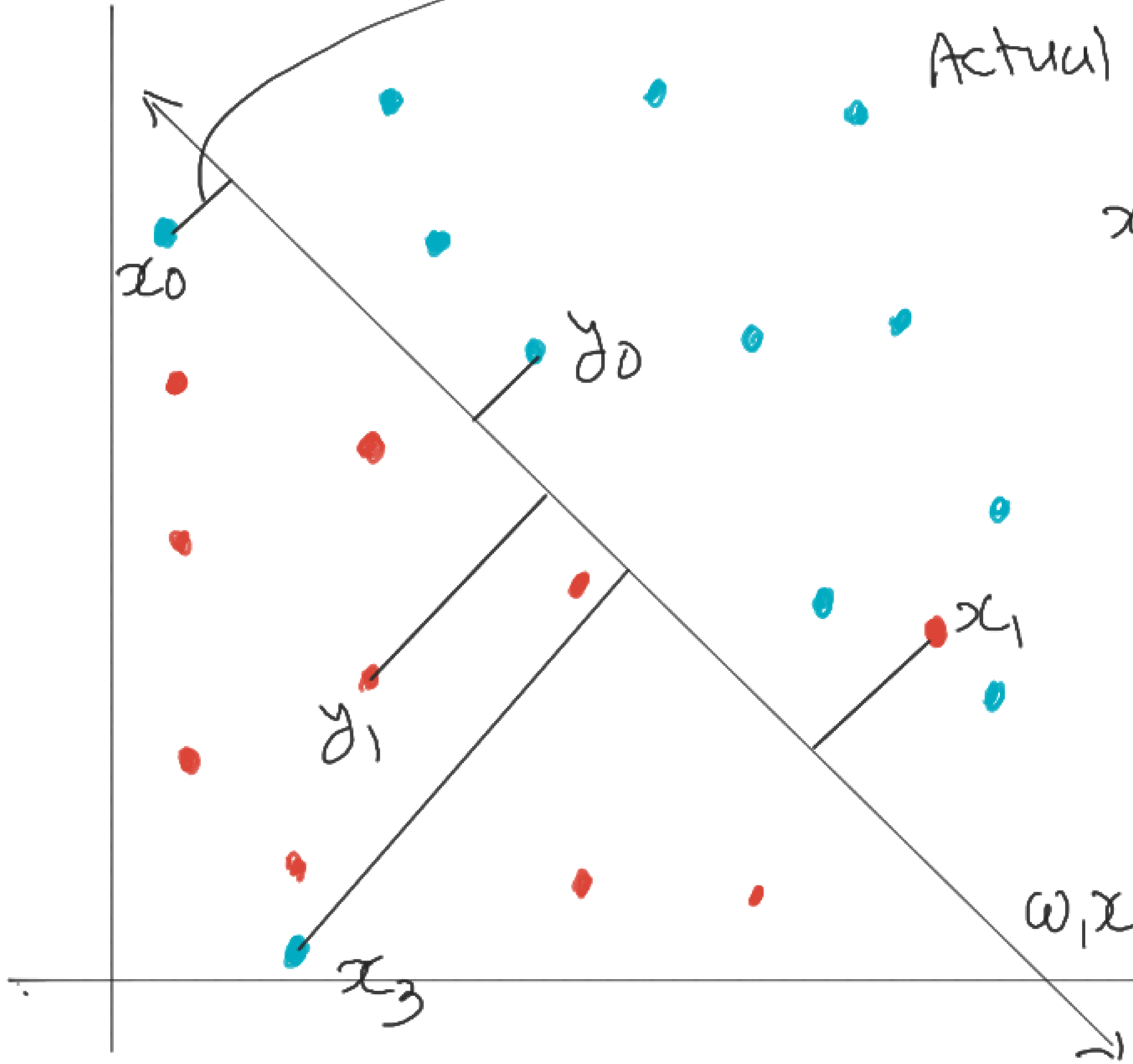


The goal is to maximize the distance of every point from the line because more the distance lesser are the chances of errors.

Calculated $d = -1$

Actual $d = +1$

$\therefore$ x_0 is misclassified



$\omega_1 x_1 + \omega_2 x_2 + \omega_0 = 0$

x_1 is also misclassified because calculated d is +ve but actual d is -ve

$$\boxed{\sum_{i=0}^{n} \frac{\omega^T \cdot x_i + \omega_0}{\|\vec{\omega}\|}}$$

Hence, our goal is to maximize this distance

★ Problems with this logic:

① +ve & -ve distances will cancel out each other.

② Misclassified points are not penalized (instead, they are appreciated)

$d(x_0) = -1$

$d(x_0) * y = (-1) * (+1) = -1$

$d(x_1) * y$

$2 * (-1) = -2$

$d(x_3) = -5$

$d(x_3) * y = (-5) * 1 = -5$

y

$+1 \rightarrow$ Big fish

$-1 \rightarrow$ small fish

$d(y_0) = +1 \quad y(y_0) = 1$

$d(y_0) * y(y_0) = +1$

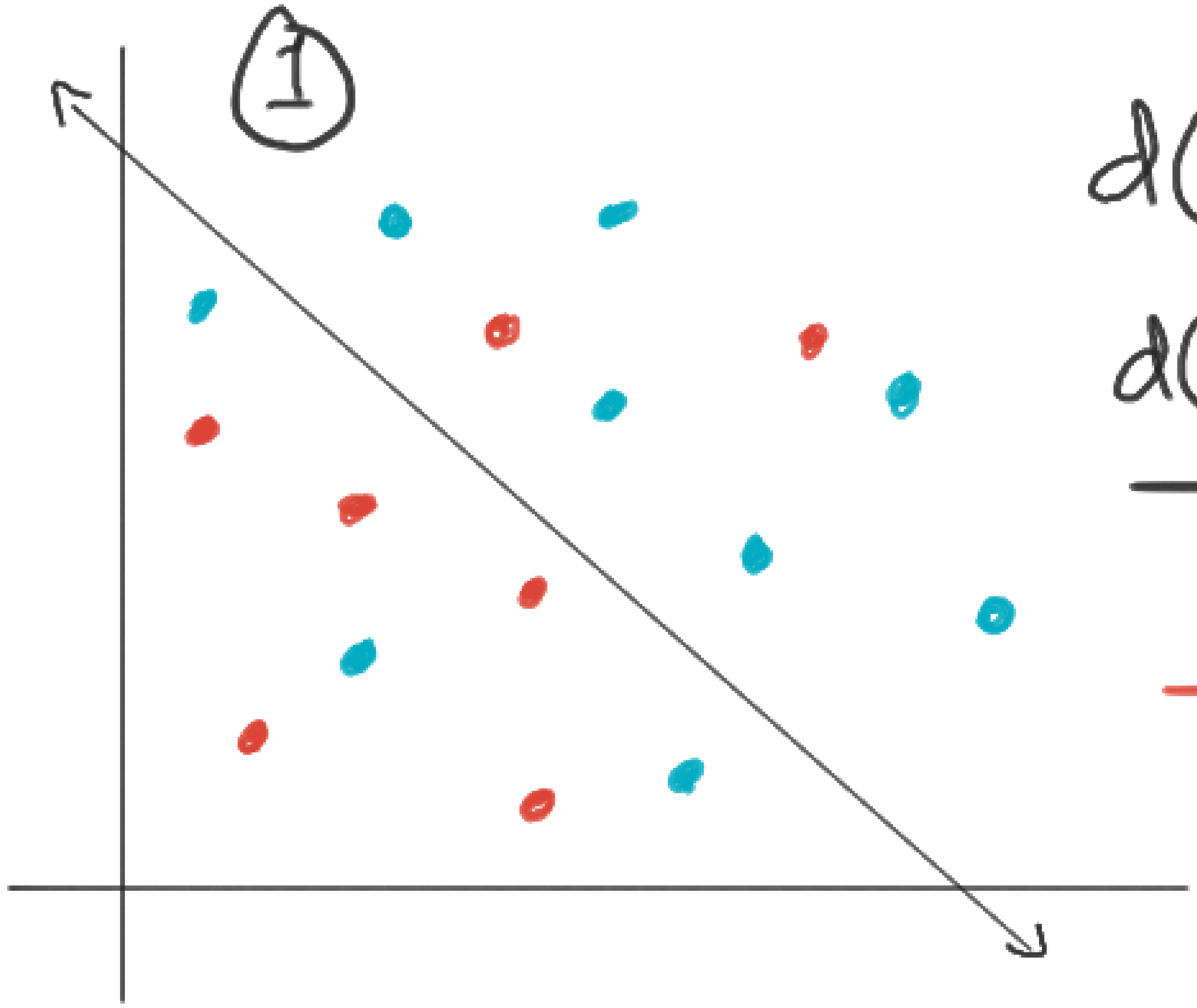
$d(y_1) = -3 \quad y(y_1) = -1$

$d(y_1) * y(y_1) = +3$

Connecting the previous formula:

$$\sum_{i=0}^{n} \frac{\vec{w}^{T} \cdot \vec{x}_i + w_0}{\|\vec{w}\|} \cdot y_i \quad \text{———} \quad \sigma(\vec{x}, \vec{w}, w_0, \vec{y})$$

$$\boxed{\text{Gain Function}}$$



d(correct) = 20

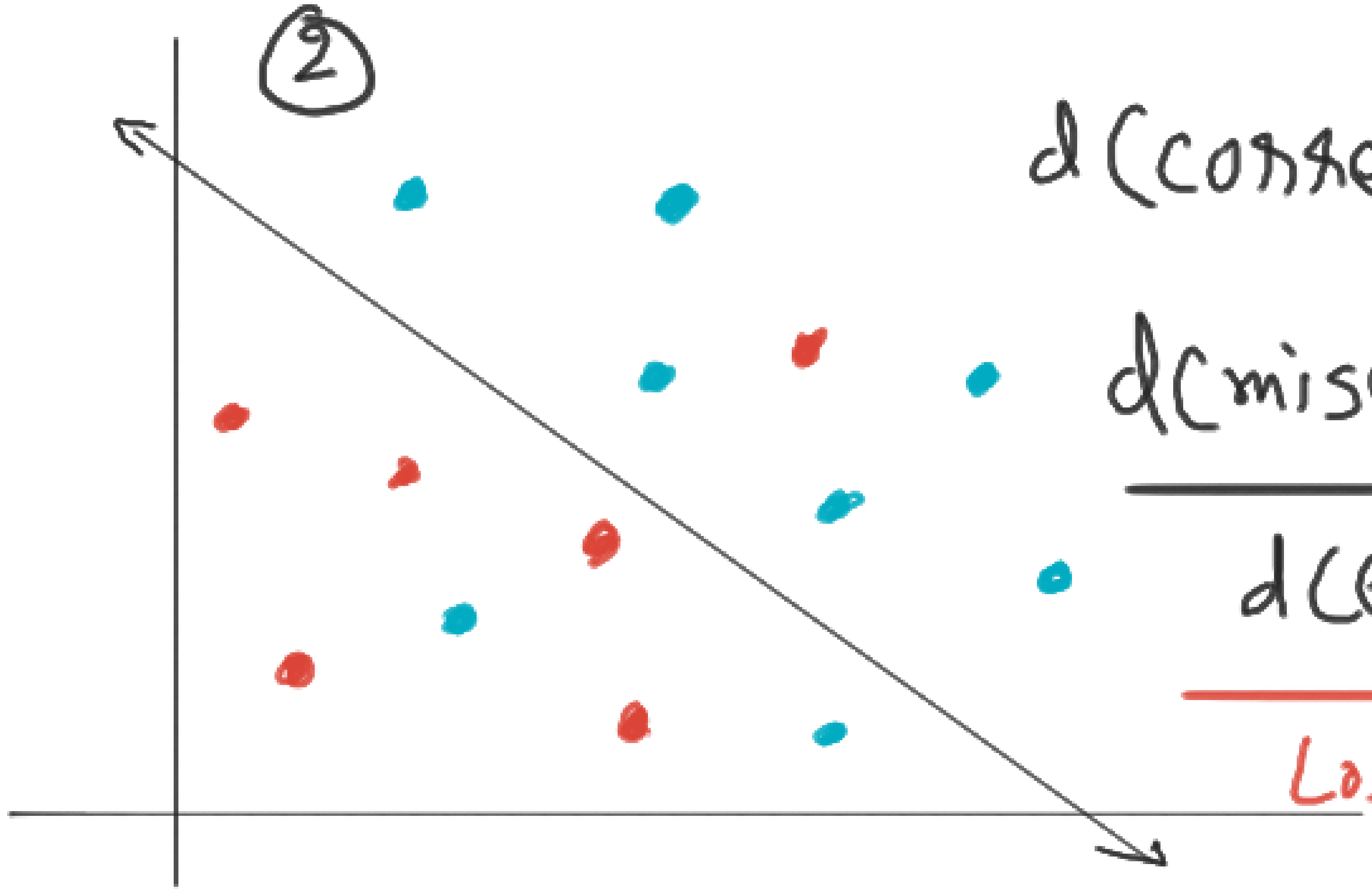
d(misclassified) = -10

---

d(eff) = 10

Loss = -10

∴ If we just invent sign of gain function, we can successfully create loss function!



d(correct) = 20

d(misclassified) = -7

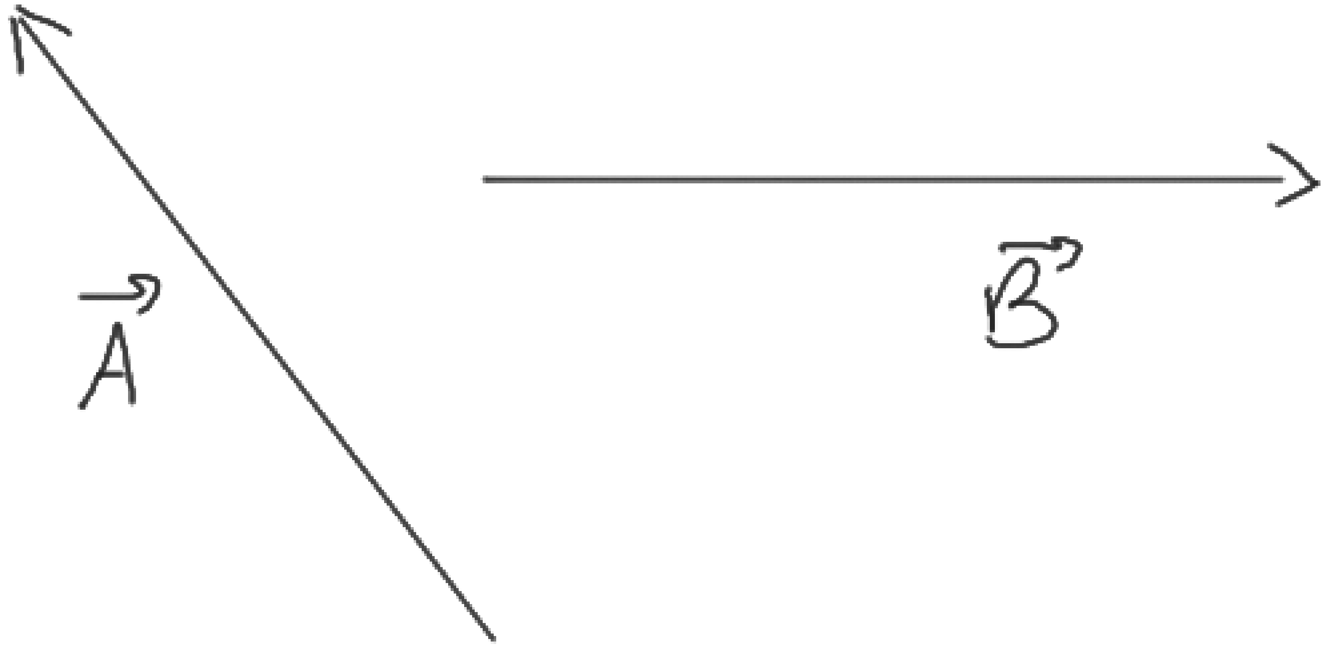
---

d(eff) = 13

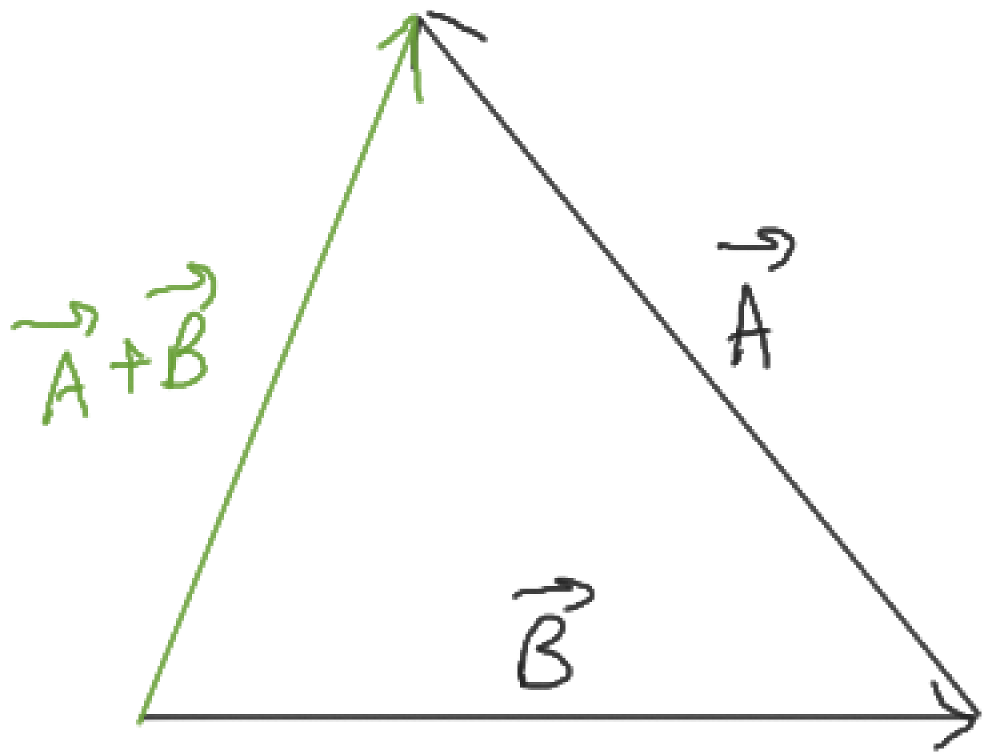
Loss = -13

$$\boxed{L(\vec{x}, \vec{w}, \vec{y}, w_0) = -\sum_{i=1}^{n}\left(\frac{\vec{w}^T \cdot x - w_0}{\|\vec{w}\|}\right)\cdot y_i}$$

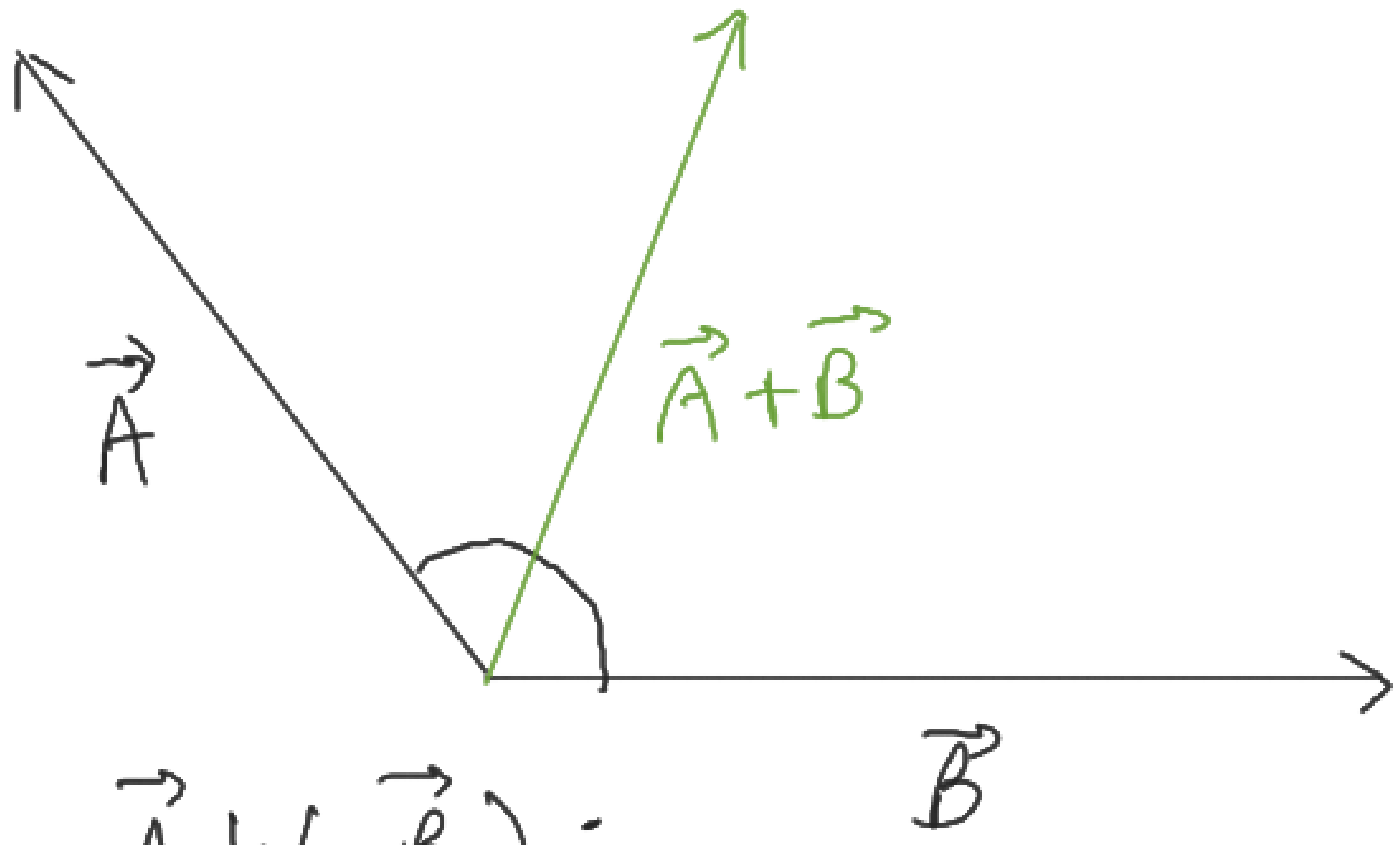
☆ An alternate approach to vector addition



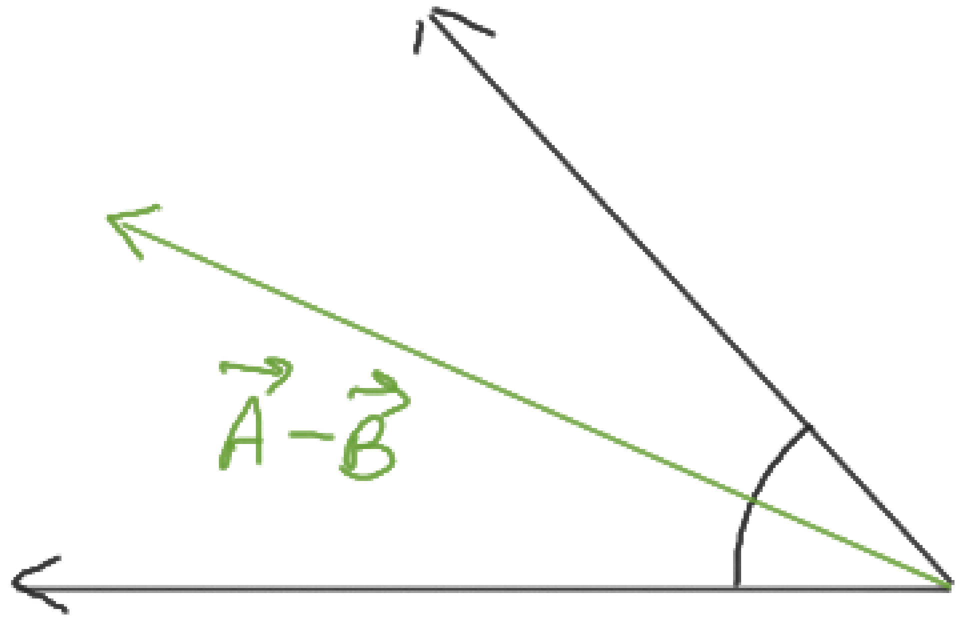
Traditional approach:



Alternate approach:



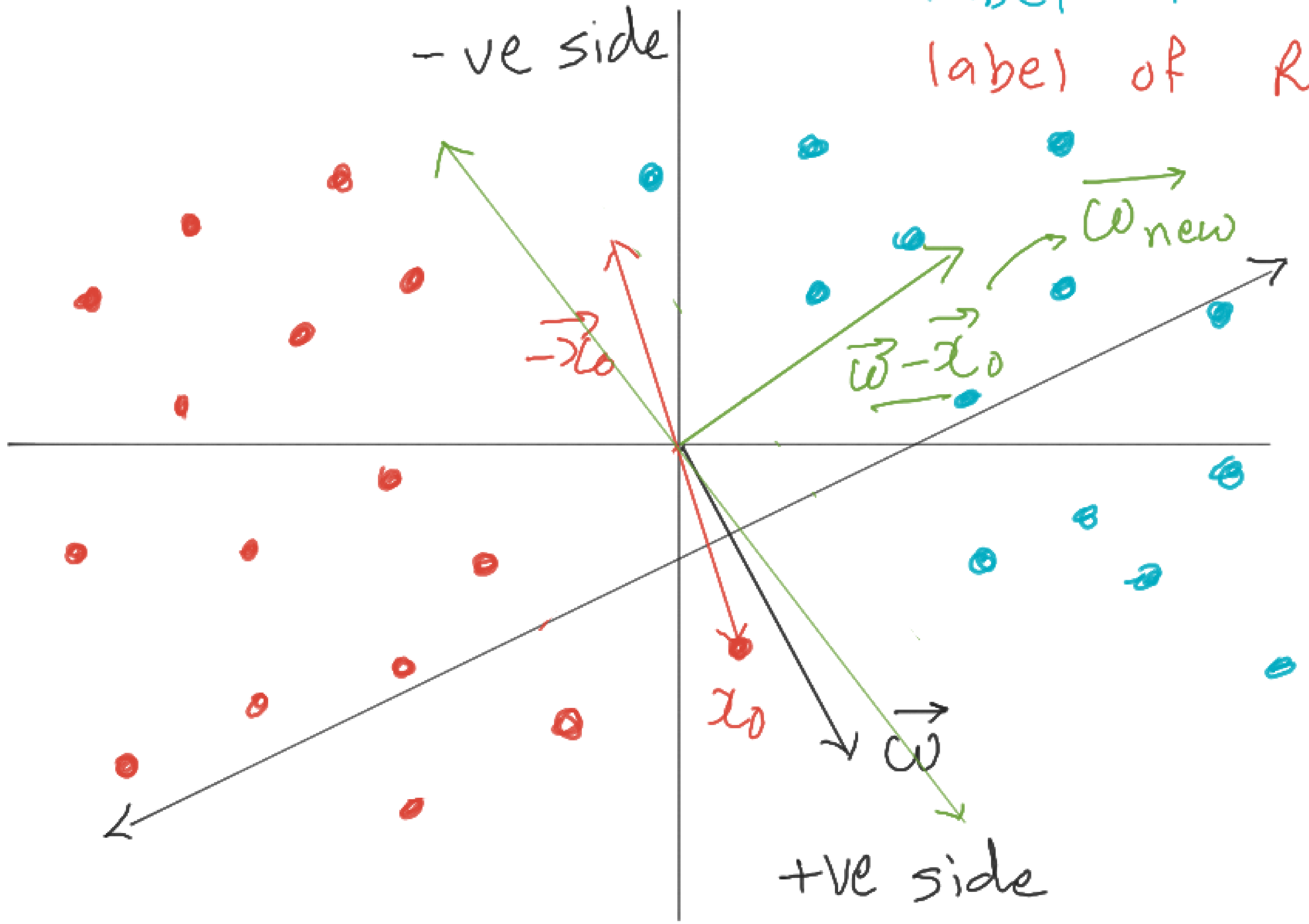
$\vec{A}-\vec{B} = \vec{A}+(-\vec{B})$:



☆ Logic behind Perceptron algorithm

label of Blue dots = 1

label of Red dots = -1



$$\vec{\omega} - \vec{x}_0 = \vec{\omega} + (-\vec{x}_0)$$