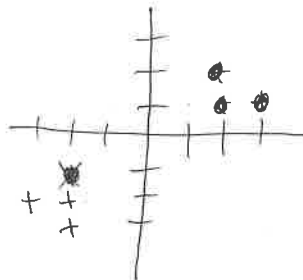


1. What  $w$  and  $b$  would a hard-margin SVM give you for the following training data? Remember that  $\gamma = \frac{1}{\|w\|}$ . (6 points)

$x_1$	$x_2$	$y$
-2	-2	1
-2	-3	1
-3	-2	1
2	1	-1
3	1	-1
2	2	-1



$$\text{dir}_w = (-4, -3)$$

$$\gamma = \frac{\sqrt{4^2 + 3^2}}{2} = 2.5 \text{ or } \frac{5}{2}$$

$$\frac{5}{2} = \frac{1}{\|w\|} \quad \|w\| = \frac{2}{5}$$

$$\text{normalize } \text{dir}_w \rightarrow \left(-\frac{4}{5}, -\frac{3}{5}\right) \cdot \frac{2}{5}$$

$$w = \left(-\frac{8}{5}, -\frac{6}{5}\right)$$

$$b = -\frac{23}{5}$$

$$-2 \cdot -\frac{8}{5} - 2 \cdot -\frac{6}{5} = \frac{28}{5}$$

$$\frac{16}{5} + \frac{12}{5} + b = 1$$

$$\frac{28}{5} + b = 1 \quad b = -\frac{23}{5}$$

2. Given  $w = (1, 1)$  and  $b = 2$ , find the  $\xi$  (slack variable) for each training sample provided below. Include your answers in the table. (4 points)

$x_1$	$x_2$	$y$	$\xi$
-2	-1	1	2
1	1	1	0
1	2	-1	6
2	2	-1	7

$$1 \cdot (-2) + 1 \cdot (-1) + 2 = -1 \quad (+2) = 1 \quad \checkmark$$

$$1 \cdot 1 + 1 \cdot 1 + 2 = 4 \quad \checkmark$$

$$1 \cdot 1 + 1 \cdot 2 + 2 = 5 \quad (-6) = -1 \quad \checkmark$$

$$1 \cdot 2 + 1 \cdot 2 + 2 = 6 \quad (-7) = -1 \quad \checkmark$$