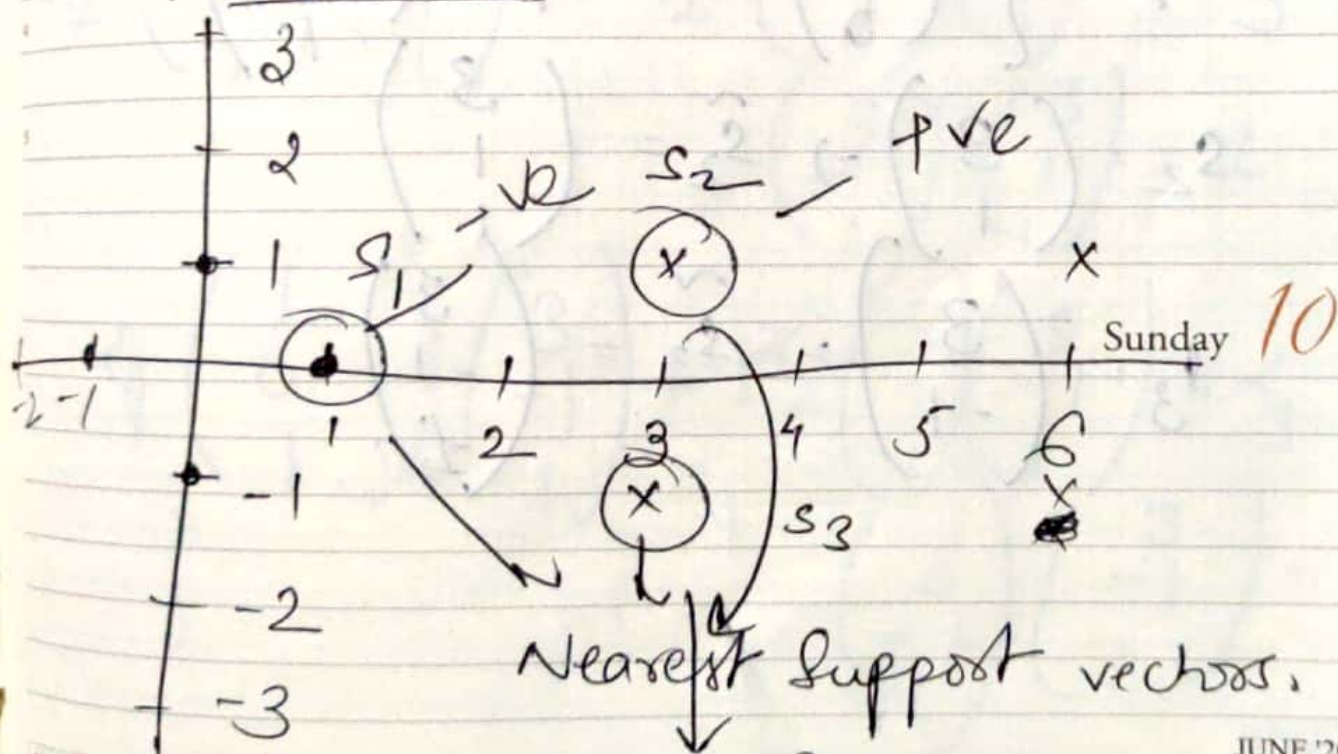Numerical Example → SVM.

$$\left\{ \begin{pmatrix} 3 \\ 1 \end{pmatrix}, \begin{pmatrix} 3 \\ -1 \end{pmatrix}, \begin{pmatrix} 6 \\ 1 \end{pmatrix}, \begin{pmatrix} 6 \\ -1 \end{pmatrix} \right\}.$$

$$\left\{ \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ -1 \end{pmatrix}, \begin{pmatrix} -1 \\ 0 \end{pmatrix} \right\}.$$

↳ Plot this data

Nearest support vectors.

JUNE '20

Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30												

$$S_1 = \left\{ \begin{pmatrix} 1 \\ 0 \end{pmatrix} \right\}$$

$$S_2 = \left\{ \begin{pmatrix} 3 \\ 1 \end{pmatrix} \right\}$$

$$S_3 = \left\{ \begin{pmatrix} 3 \\ -1 \end{pmatrix} \right\}.$$

Add "1" as a bias input

$$S_1 = \left\{ \begin{pmatrix} 1 \\ 0 \end{pmatrix} \right\} \Rightarrow \tilde{S}_1 = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$$

$$S_2 = \begin{pmatrix} 3 \\ 1 \end{pmatrix} \Rightarrow \tilde{S}_2 = \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix}$$

$$S_3 = \begin{pmatrix} 3 \\ -1 \end{pmatrix} = \tilde{S}_3 = \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix}.$$

$$\alpha_1 \tilde{S}_1 \cdot \tilde{S}_1 + \alpha_2 \tilde{S}_2 \cdot \tilde{S}_1 + \alpha_3 \tilde{S}_3 \cdot \tilde{S}_1 = -1$$

$$\alpha_1 \tilde{S}_1 \tilde{S}_2 + \alpha_2 \tilde{S}_2 \tilde{S}_2 + \alpha_3 \tilde{S}_3 \tilde{S}_3 = +1$$

$$\alpha_1 \tilde{S}_1 \tilde{S}_3 + \alpha_2 \tilde{S}_2 \tilde{S}_3 + \alpha_3 \tilde{S}_3 \tilde{S}_3 = +1$$

$$\alpha_1 \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} + \alpha_2 \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} + \alpha_3 \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} = -1$$

$$\alpha_2 \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix} + \alpha_2 \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix} + \alpha_3 \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix} = 1$$

$$\alpha_1 \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} + \alpha_2 \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} + \alpha_3 \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} = 1$$

JUNE '20

Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30												

$$\alpha_1 \left(1+0+1\right) + \alpha_2 \left(3+0+1\right) + \alpha_3$$

$$\left(3+0+1\right) = -1$$

$$\alpha_1 \left(3+0+1\right) + \alpha_2 \left(9+1+1\right) +$$

$$\alpha_3 \left(9-1+1\right) \cdot 1$$

$$\alpha_1 \left(3+0+1\right) + \alpha_2 \left(9-1+1\right) +$$

$$\alpha_3 \left(9+1+1\right) = 1$$

$$2\alpha_1 + 4\alpha_2 + 4\alpha_3 = -1$$

$$4\alpha_1 + 11\alpha_2 + 9\alpha_3 = 1$$

$$4\alpha_1 + 9\alpha_2 + 11\alpha_3 = 1$$

MAY '20

Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27	28	29	30	31							

$$\alpha_1 = -3.5$$

$$\alpha_2 = 0.75$$

$$\alpha_3 = 0.75$$

$$\tilde{w} = \sum_i \alpha_i \tilde{s}_i$$

$$= -3.5 \begin{pmatrix} 1 \\ 9 \end{pmatrix} + 0.75 \begin{pmatrix} 3 \\ 1 \\ 1 \end{pmatrix} + 0.75 \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix}$$

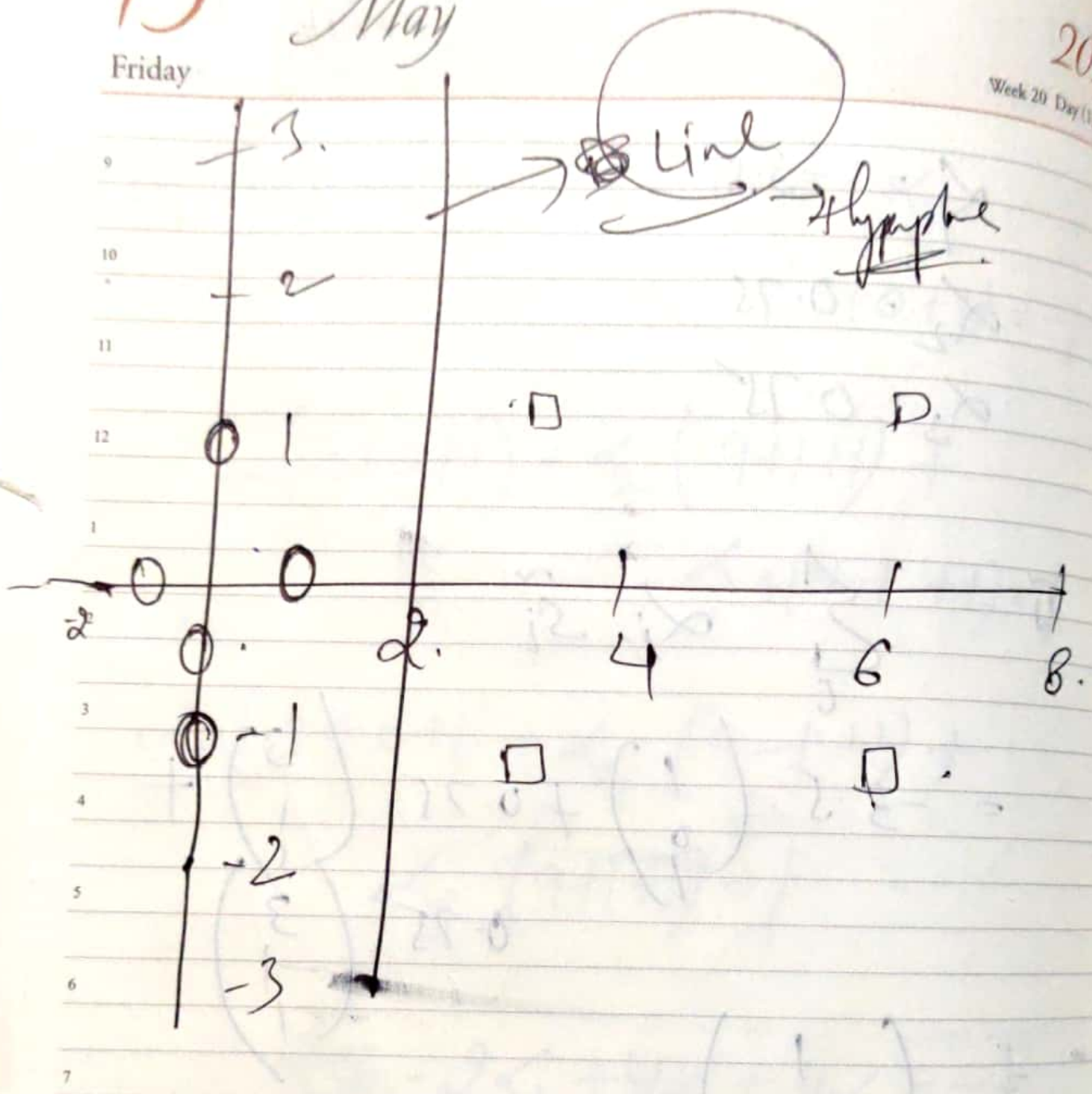$$\approx \begin{pmatrix} 1 \\ 0 \\ -2 \end{pmatrix}$$

$$y = wx + b . \quad \longrightarrow \quad \text{parallel to } y\text{-axis}$$

$$w = \begin{pmatrix} 1 \\ 0 \end{pmatrix} , \quad b = -2 .$$

JUNE '20

Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21							
22	23	24	25	26	27	28	29	30					

9

10

11

12

1

2

3

4

5

6

7

3.

2

1

0 2. 4 6 8.

—1

—2

—3

D.

MAY '20

Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27	28	29	30	31							