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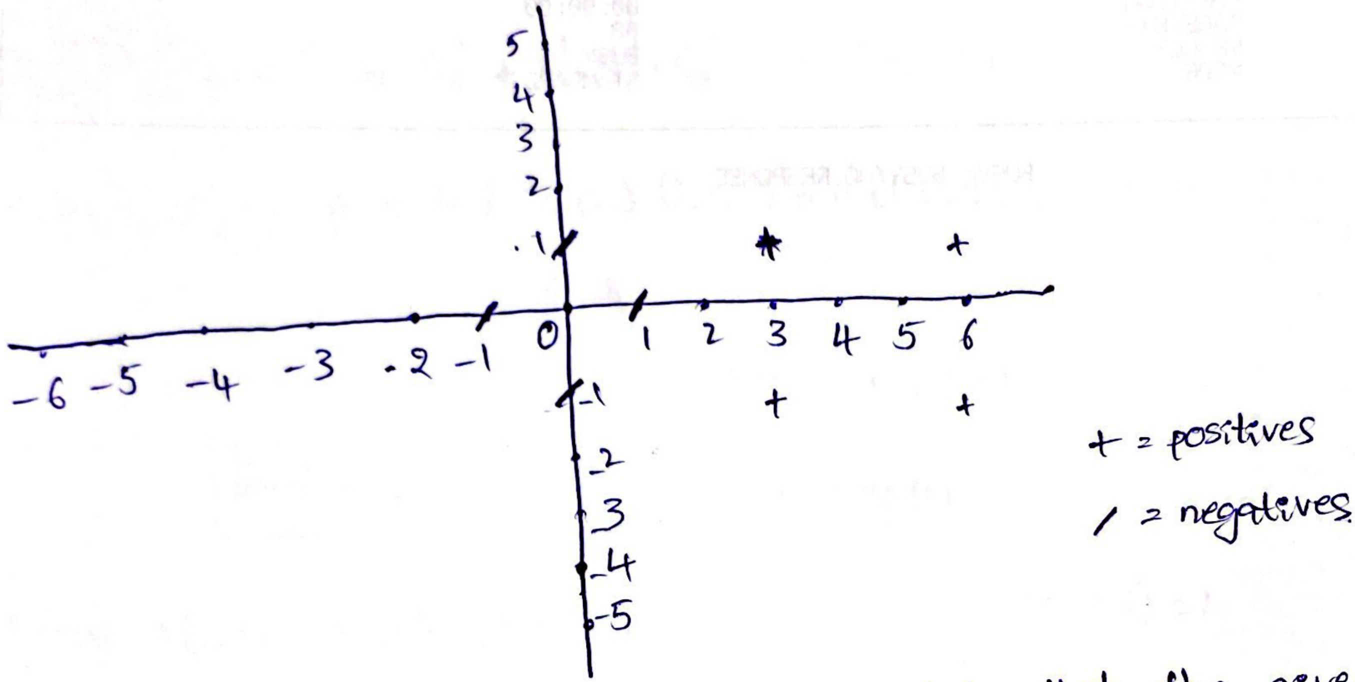
DataMining Assignment [A5]

Q1

Given points -> (3,1) (3,-1) (6,1) (6,-1) (1,0) (0,1) (0,-1) (-1,0)



a) From the above, we can clearly state that the given points are linearly seperable, hence we can say a linear SVM is sufficient for solving this problem.

b) The support vectors from the graph are

(1,0) (3,1) (3,-1)

c) Support vectors $s_1(1,0)$, $s_2(3,1)$, $s_3(3,-1)$

after adding constant $D=1$ the support vectors are.

$s_1^1 = (1,0,1)$

$s_2^1 = (3,1,1)$

$s_3^1 = (3,-1,1)$

Co-efficients of w_1', w_2', b' can be calculated from below equation

$w_1' \cdot s_1' s_1' + w_2' s_1' s_2' + b' s_1' s_3' = -1$ (∵ y value of $s_1 = -1$)

$w_1' \cdot s_1' \cdot s_2' + w_2' s_2' s_2' + b' s_2' s_3' = 1$ ($\cancel{s_2 = 1}$) (∵ y value of $s_2 = 1$)

$w_1' \cdot s_1' \cdot s_3' + w_2' \cdot s_2' \cdot s_3' + b' \cdot s_3' \cdot s_3' = 1$ ($s_3 = 1$)

$w_1'(1,0,1)(1,0,1) + w_2'(1,0,1)(3,1,1) + b'(1,0,1)(3,-1,1) = -1$

$w_1'(1+0+1) + w_2'(3+0+1) + b'(3+0+1) = -1$

$\boxed{2w_1' + 4w_2' + 4b' = -1} \rightarrow eq(1)$

$w_1'(1,0,1)(3,1,1) + w_2'(3,1,1)(3,1,1) + b'(3,1,1)(3,-1,1) = 1$

$w_1'(3+0+1) + w_2'(9+1+1) + b'(9-1+1) = 1$

$\boxed{4w_1' + 11w_2' + 9b' = 1} \rightarrow eq(2)$

$w_1'(1,0,1)(3,-1,1) + w_2'(3,1,1)(3,-1,1) + b'(3,-1,1)(3,-1,1) = 1$

$w_1'(3+0+1) + w_2'(9-1+1) + b'(9+1+1) = 1$

$\boxed{4w_1' + 9w_2' + 11b' = 1} \rightarrow eq(3)$

After solving the above eqns

$w_1' = -3.5$, $w_2' = 0.75$, $b' = 0.75$

$[w_1, w_2, b] = w_1' \cdot s_1' + w_2' \cdot s_2' + b' \cdot s_3'$

$= -3.5[1\ 0\ 1] + 0.75[3, 1, 1] + 0.75[3, -1, 1]$

$= [-3.5 \quad 0 \quad -3.5] + [2.25 \quad 0.75 \quad 0.75] + [2.25 \quad -0.75 \quad 0.75]$

$[w_1, w_2, b] = [1, 0, -2]$

$\therefore$ The equation of line Seperating datapoints is

$$w_1 x_1 + w_2 x_2 + b = 0$$

$$x_1 + 0 - 2 = 0$$

$$\boxed{x_1 = 2}$$

The equation of line is $x_1 - 2 = 0$ //

d) Given points to classify are $(0,0)$ $(3,3)$

i) $(0,0)$ by substituting the point in the eqn obtained we can decide the y value of given data point

for $(0,0)$ $y = 0 - 2 = -2$

Since the value of $w_1 x_1 + w_2 x_2$ is less than 0 the value of y for the point is -1 $x_1 = 0, x_2 = 0, y = -1$

ii) $(3,3)$

$y = 3 - 2 = 1$

Since value of $w_1 x_1 + w_2 x_2 > 0$ the value of y for point is 1

$x_1 = 3, \quad x_2 = 3, \quad y = 1.$

Q2

Given

Timestamp	x_1	x_2	y
t_1	0.3	0.6	0.2
t_2	0.1	1.0	0.4

When Timestamp = 1

forget gate variable $f_1 = \sigma\left[W_f[x_1\ y_0] + b_f\right)$

$$= \sigma\left(\begin{bmatrix}0.7\\0.4\\0.1\end{bmatrix}\begin{pmatrix}0.3\\0.6\\0\end{pmatrix} + 0.1\right)$$

$$= \sigma(0.7 * 0.3 + 0.4\ 0.6 + 0.1\ 0 + 0.1)$$

$$= \sigma(0.55) \qquad \sigma(x) = \frac{1}{1+e^{-x}}$$

$\boxed{f_1 = 0.6341}$

input gate variable $i_1 = \sigma(W_i[x_1\ y_0] + b_i)$

$$= \sigma\left(\begin{pmatrix}0.2\\0.6\\0.7\end{pmatrix}\begin{pmatrix}0.3\\0.6\\0\end{pmatrix} + 0.4\right)$$

$$= \sigma(0.2 \cdot 0.3 + 0.6 \cdot 0.6 + 0.7 \cdot 0 + 0.4)$$

$$= \sigma(0.06 + 0.36 + 0.4)$$

$$= \sigma(0.82)$$

$\boxed{i_1 = 0.6942}$

Input Activation variable. $a_1 = \tanh\left[W_a[x_1\ y_0] + b_a\right)$

$$= \tanh\left(\begin{pmatrix}0.3\\0.2\\0.1\end{pmatrix}\begin{pmatrix}0.3\\0.6\\0\end{pmatrix} + 0.3\right)$$

$$= \tanh(0.3\ 0.3 + 0.2\ 0.6 + 0.1\ 0 + 0.3)$$

$$= \tanh(0.51)$$

$\boxed{\therefore a_1 = 0.4699}$

Internal state variable $s_1 = f_1 s_0 + i_1 \cdot a_1$

$$= 0.6341 + 0.6942 \cdot 0.4699$$

$$\boxed{s_1 = 0.3262}$$

Output gate variable $o_1 = \sigma(w_o[x_1\ y_0] + b_o)$

$$= \sigma\left(\begin{pmatrix} 0.6 \\ 0.3 \\ 0.1 \end{pmatrix}\begin{pmatrix} 0.3 \\ 0.6 \\ 0 \end{pmatrix} + 0.2\right)$$

$$= \sigma(0.18 + 0.18 + 0 + 0.2) = \sigma(0.56)$$

$$\boxed{o_1 = 0.6365}$$

final output variable $y_1 = o_1 \tanh(s_1)$

$$= 0.6365 \tanh(0.3262)$$

$$\boxed{y_1 = 0.2006}$$

When Timestamp = 2

forget gate variable $f_2 = \sigma(w_f[x_2\ y_1] + b_f)$

$$= \sigma\left(\begin{pmatrix} 0.7 \\ 0.4 \\ 0.1 \end{pmatrix}\begin{pmatrix} 0.1 \\ 1.0 \\ 0.2006 \end{pmatrix} + 0.1\right)$$

$$= \sigma(0.07 + 0.4 + 0.02006 + 0.1) = \sigma(0.59006)$$

$$\boxed{f_2 = 0.6434}$$

Input gate variable $i_2 = \sigma(w_i[x_2\ y_1] + b_i)$

$$= \sigma\left(\begin{pmatrix} 0.2 \\ 0.6 \\ 0.7 \end{pmatrix}\begin{pmatrix} 0.1 \\ 1.0 \\ 0.2006 \end{pmatrix} + 0.4\right)$$

$$= \sigma(0.02 + 0.6 + 0.14042 + 0.4)$$

$$= \sigma(1.16042)$$

$$\boxed{i_2 = 0.7614}$$

Input activation variable $a_2 = \tanh[w_a[x_2\ y_1] + b_a]$

$$= \tanh\left(\begin{pmatrix}0.3\\0.2\\0.1\end{pmatrix}\begin{bmatrix}0.1\\1.0\\0.2006\end{bmatrix} + 0.3\right)$$

$$= \tanh(0.03 + 0.2 + 0.02006 + 0.3)$$

$$= \tanh(0.55006)$$

$$\boxed{a_2 = 0.5006}$$

Internal state variable $s_2 = f_2 \cdot s_1 + i_2 a_2$

$$= 0.6434\ 0.3262 + 0.7614 \cdot 0.5006$$

$$= 0.2099 + 0.3812$$

$$\boxed{s_2 = 0.5911}$$

Output gate variable $o_2 = \sigma(w_o[x_2\ y_1] + b_o)$

$$= \sigma\left[\begin{pmatrix}0.6\\0.3\\0.1\end{pmatrix}\begin{pmatrix}0.1\\1.0\\0.2006\end{pmatrix} + 0.2\right)$$

$$= \sigma(0.06 + 0.3 + 0.02006 + 0.2)$$

$$= \sigma(0.58606)$$

$$\boxed{o_2 = 0.6411}$$

final output variable $y_2 = o_2 \tanh(s_2)$

$$= 0.6411 \cdot 0.5307$$

$$\boxed{y_2 = 0.3402}$$

5) error of final output variable at $t_1 = y_1 - y$

$t_1 = 0.2006 - 0.2$

error $= 0.0006$

error of final output vaiable at $t_c = y_2 - y_1$

$t_c = 0.3402 - 0.4$

$\boxed{\text{error} = -0.0598}$