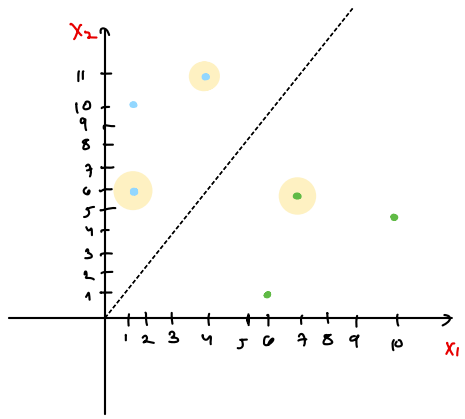
# SVM

1)

| $x_1$ | $x_2$ | class |
|---|---|---|
| 1 | 6 | - |
| 1 | 10 | - |
| 4 | 11 | - |
| 6 | 1 | + |
| 7 | 6 | + |
| 10 | 4 | + |




support vectors:

$\begin{pmatrix}1\\6\end{pmatrix}\begin{pmatrix}4\\11\end{pmatrix}\begin{pmatrix}7\\6\end{pmatrix}$

$S_1 = \begin{pmatrix}1\\6\\1\end{pmatrix}$
$S_2 = \begin{pmatrix}4\\11\\1\end{pmatrix}$
$S_3 = \begin{pmatrix}7\\6\\1\end{pmatrix}$

1. $a_1\begin{pmatrix}1\\6\\1\end{pmatrix}\begin{pmatrix}1\\6\\1\end{pmatrix} + a_2\begin{pmatrix}4\\11\\1\end{pmatrix}\begin{pmatrix}1\\6\\1\end{pmatrix} + a_3\begin{pmatrix}7\\6\\1\end{pmatrix}\begin{pmatrix}1\\6\\1\end{pmatrix} = -1$

2. $a_1\begin{pmatrix}1\\6\\1\end{pmatrix}\begin{pmatrix}4\\11\\1\end{pmatrix} + a_2\begin{pmatrix}4\\11\\1\end{pmatrix}\begin{pmatrix}4\\11\\1\end{pmatrix} + a_3\begin{pmatrix}7\\6\\1\end{pmatrix}\begin{pmatrix}4\\11\\1\end{pmatrix} = -1$

3. $a_1\begin{pmatrix}1\\6\\1\end{pmatrix}\begin{pmatrix}7\\6\\1\end{pmatrix} + a_2\begin{pmatrix}4\\11\\1\end{pmatrix}\begin{pmatrix}7\\6\\1\end{pmatrix} + a_3\begin{pmatrix}7\\6\\1\end{pmatrix}\begin{pmatrix}7\\6\\1\end{pmatrix} = 1$

1. $a_1(1+36+1) + a_2(4+66+1) + a_3(7+36+1) = 38a_1 + 71a_2 + 44a_3 = -1$

2. $a_1(4+66+1) + a_2(16+121+1) + a_3(28+66+1) = 71a_1 + 138a_2 + 95a_3 = -1$

3. $a_1(7+36+1) + a_2(28+66+1) + a_3(49+36+1) = 44a_1 + 95a_2 + 86a_3 = 1$

$a_1 = \frac{-61}{225}$

$a_2 = \frac{3}{25}$

$a_3 = \frac{4}{225}$

$-\frac{61}{225}\cdot\begin{pmatrix}1\\6\\1\end{pmatrix} + \frac{3}{25}\cdot\begin{pmatrix}4\\11\\1\end{pmatrix} + \frac{4}{225}\cdot\begin{pmatrix}7\\6\\1\end{pmatrix} = \begin{pmatrix}1/3\\-1/5\\-2/15\end{pmatrix}$ :נרמל

$w = \frac{1}{3}x_1 - \frac{1}{5}x_2 - \frac{2}{15} = 0$ (=

$\begin{pmatrix}1/3\\-1/5\end{pmatrix}$ : hyperplane - ה וקטור נורמלי

$-2/15$ : offset

2) margin $= \frac{2}{\sqrt{w^T w}} = \frac{2}{\sqrt{\left(\frac{1}{3}, -\frac{1}{5}, \frac{-2}{15}\right)\cdot\begin{pmatrix}1/3\\-1/5\\-2/15\end{pmatrix}}} = \frac{2}{\sqrt{38/225}} = \frac{5\sqrt{2}}{\sqrt{19}}$