(1) $W = [3, 4]^T = \begin{bmatrix} 3 \\ 4 \end{bmatrix} = \frac{1}{\sqrt{3^2 + 4^2}} \begin{bmatrix} 3 \\ 4 \end{bmatrix} = \frac{1}{5} \begin{bmatrix} 3 \\ 4 \end{bmatrix}$

$x = [x, y]^T$

$x_0 = [2, 1]$

$$\frac{1}{5} \begin{bmatrix} 3 \\ 4 \end{bmatrix} \cdot \left(\begin{bmatrix} x \\ y \end{bmatrix} - \begin{bmatrix} 2 \\ 1 \end{bmatrix} \right) = 0$$

$$\frac{1}{5} \begin{bmatrix} 3 \\ 4 \end{bmatrix} \cdot \begin{pmatrix} x - 2 \\ y - 1 \end{pmatrix} = 0$$

$$\frac{1}{5} (3x - 6 + 4y - 4) = 0$$

$$\frac{1}{5} (3x + 4y - 10) = 0$$

$$\underline{\underline{\frac{3}{5}x + \frac{4}{5}y - 2 = 0}}$$

$P(-2 / 4) \in g = \frac{3}{5} \cdot -2 + \frac{4}{5} \cdot 4 - 2$

$$-\frac{6}{5} + \frac{16}{5} - 2 = 0$$

Distanz $(2, 5)$:

$$\frac{6}{5} + \frac{20}{5} - 2 = \underline{\underline{3,2}}$$

2

Simple Example by Hand

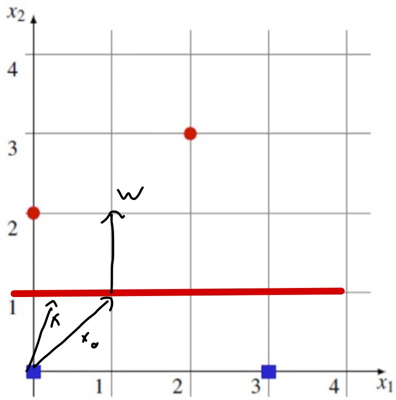
For the decision problem with two classes **blue** (blue squares, $y = 1$) and **red** (red circles, $y = -1$) depicted below find, using only graphical means, i.e. there is no complicated mathematical machinery involved, other then basic geometrical math

1. the support vectors
2. the non-support vectors
3. the *decision function* in the form

$$w_1x_1 + w_2x_2 + b = 0$$

   such that for the support vectors the following holds: $w_1x_1 + w_2x_2 + b = \pm 1$.

4. Draw the decision line in the graph on the right side.



1.) Support Vectors = $[0,2]^T$ & $[0,0]^T$ & $[3,0]$

2.) Non Support Vectors = $[2,3]^T$

3.) $w = [0,1]^T = \begin{bmatrix}0\\1\end{bmatrix}$

$$\begin{bmatrix}0\\1\end{bmatrix} \cdot \left(\begin{bmatrix}x_1\\x_2\end{bmatrix} - \begin{bmatrix}1\\1\end{bmatrix}\right)$$

$$= (0 \cdot (x_1 - 1)) + (1 \cdot (x_2 - 1)) = x_2 - 1 = 0$$

③

Minimization Problem

Given the decision problem of the previous exercise.

1. Write down the minimization problem (see top of slide 27/44).
2. Write down the minimization problem using the method of Lagrangian multipliers (see middle of slide 27/44).
3. Write down the dual problem using the partial derivatives in the middle of slide 28/44.

Note: here You'll have to use the math behind the SVM!

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