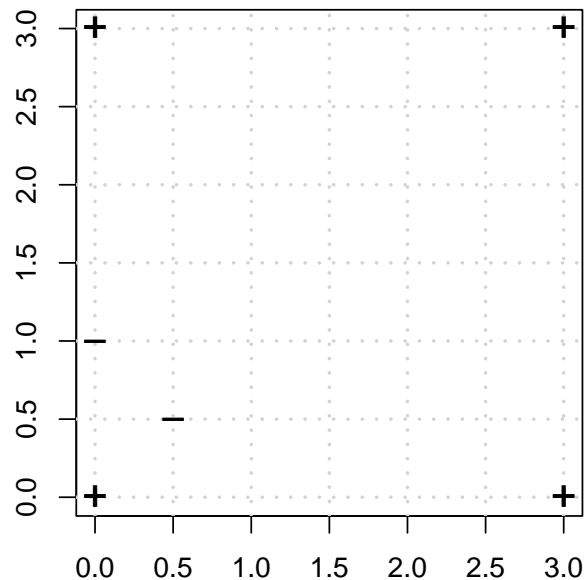


### Exercise 1: SVM - Support Vectors and Separating Hyperplane

The primal optimization problem for the two-class soft margin SVM classification is given by

$$\begin{aligned} \min_{\theta, \theta_0, \zeta^{(i)}} \quad & \frac{1}{2} \|\theta\|^2 + C \sum_{i=1}^n \zeta^{(i)} \\ \text{s.t. :} \quad & y^{(i)} (\theta^\top \mathbf{x}^{(i)} + \theta_0) \geq 1 - \zeta^{(i)}, \\ & \zeta^{(i)} \geq 0, \quad \forall i = 1, \dots, n. \end{aligned}$$



- (a) Add the decision boundary to the figure for  $\hat{\theta} = (1, 1)^T, \hat{\theta}_0 = -2$ . (NB: This is the approximate optimum for  $C = 10$ )
- (b) Identify the coordinates of the support vector(s) and compute the values of their slack variables  $\zeta^{(i)}$ .
- (c) Compute the Euclidean distance of the non-margin-violating support vector(s) (i.e. support vectors that are located on the margin hyperplanes) to the decision boundary.

- (d) What needs to be changed in the plot such that a hard margin SVM results into the same decision boundary?
- (e) Quiz time: Log in to Particify (<https://partici.fi/63221686>) and try to answer the questions for **Week 9** and **Week 10**.