

# 1 Classification Methods

Classification is the assignment of objects (data points) to categories (classes). It requires a data set (i.e. training set) of points with known class labels. If the class labels are not known you can instead group the data using clustering algorithms (chapter 2).

## 1.1 Linear Classifiers

Linear classifiers use linear decision boundaries to classify points to a respective class.

## 1.2 Support Vector Classifier (SVC)

SVCs use hyperplanes to separate data points according to their class label with a maximum margin ( $M$ ) between the separating hyperplane ( $x^T \beta + \beta_0 = 0$ ) and the points. If points cannot be perfectly separated by the decision boundary, a soft margin SVM is used with a slack variable  $\xi$  that punishes points in the margin or on the wrong side of the hyperplane. The optimization problem is given by [?]:

$$\begin{aligned} & \max_{\beta, \beta_0, \xi} M, \\ & \text{subject to } y_i(x_i^T \beta + \beta_0) \geq 1 - \xi_i, \quad \forall i, \\ & \xi_i \geq 0, \quad \sum \xi_i \leq \text{constant}, \quad i = 1, \dots, N, \end{aligned} \tag{1}$$

where  $\beta$  are the coefficients and  $x$  are the  $N$  data points. The support vectors are the points that determine the orientation of the hyperplane (i.e. the closest points). The classification function is given by:

$$G(x) = \text{sign}[x^T \beta + \beta_0] \tag{2}$$