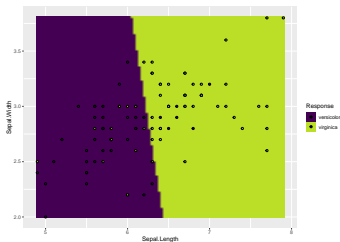


# Introduction to Machine Learning

## Classification: Linear Classifiers



### Learning goals

- Know the definition of a linear classifier

# LINEAR CLASSIFIERS

Linear classifiers are an important subclass of classification models. If the discriminant function(s)  $f_k(\mathbf{x})$  can be specified as linear function(s) (possibly through a rank-preserving, monotone transformation  $g : \mathbb{R} \rightarrow \mathbb{R}$ ), i. e.

$$g(f_k(\mathbf{x})) = \mathbf{w}_k^\top \mathbf{x} + b_k,$$

we will call the classifier a **linear classifier**.

# LINEAR CLASSIFIERS

We can also easily show that the decision boundary between classes  $i$  and  $j$  is a hyperplane. For every  $\mathbf{x}$  where there is a tie in scores:

$$\begin{aligned}f_i(\mathbf{x}) &= f_j(\mathbf{x}) \\g(f_i(\mathbf{x})) &= g(f_j(\mathbf{x})) \\ \mathbf{w}_i^\top \mathbf{x} + b_i &= \mathbf{w}_j^\top \mathbf{x} + b_j \\ (\mathbf{w}_i - \mathbf{w}_j)^\top \mathbf{x} + (b_i - b_j) &= 0\end{aligned}$$

This is a **hyperplane** separating two classes.

# LINEAR VS NONLINEAR DECISION BOUNDARY

