



Figure 5.8 Example of the class-conditional densities for two classes having a single input variable x (left plot) together with the corresponding posterior probabilities (right plot). Note that the left-hand mode of the class-conditional density $p(x|\mathcal{C}_1)$, shown in blue on the left plot, has no effect on the posterior probabilities. The vertical green line in the right plot shows the decision boundary in x that gives the minimum misclassification rate, assuming the prior class probabilities, $p(\mathcal{C}_1)$ and $p(\mathcal{C}_2)$, are equal.

the vertical green line, because this is the decision boundary giving the minimum probability of misclassification.

With option (c), however, we no longer have access to the posterior probabilities $p(\mathcal{C}_k|\mathbf{x})$. There are many powerful reasons for wanting to compute the posterior probabilities, even if we subsequently use them to make decisions. These include:

Minimizing risk. Consider a problem in which the elements of the loss matrix are subjected to revision from time to time (such as might occur in a financial application). If we know the posterior probabilities, we can trivially revise the minimum risk decision criterion by modifying (5.23) appropriately. If we have only a discriminant function, then any change to the loss matrix would require that we return to the training data and solve the inference problem afresh.

Reject option. Posterior probabilities allow us to determine a rejection criterion that will minimize the misclassification rate, or more generally the expected loss, for a given fraction of rejected data points.

Section 2.1.1

Compensating for class priors. Consider our cancer screening example again, and suppose that we have collected a large number of images from the general population for use as training data, which we use to build an automated screening system. Because cancer is rare amongst the general population, we might find that, say, only 1 in every 1,000 examples corresponds to the presence of cancer.