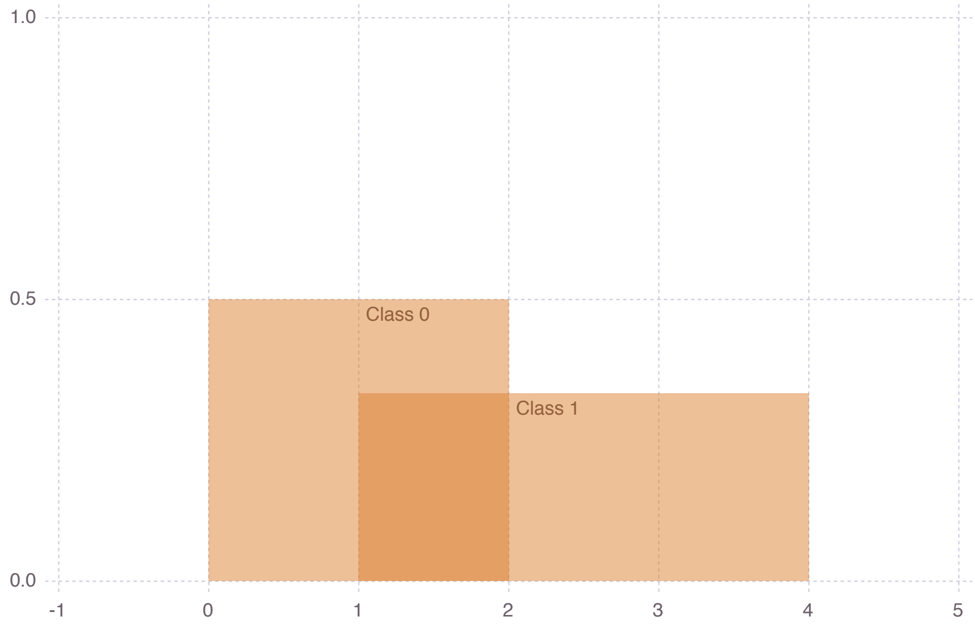
5

This question is most easily explained by overlaying the PDF's of the two classes:



The bayes classifier is very simple, from 0-2, pick 0, while from 2-4, you pick 1. The Bayes risk is simply the overlapping area in the graph of the two PDF's. When values are between 1-2, there is a risk of 2/5. This is obtained by summing all the possibilities to obtain our marginilizing constant, and then taking the density of class 1 over the area (1/3):

$$\frac{\frac{1}{3}}{\frac{1}{3} + \frac{1}{2}} = \frac{2}{5}$$

To compute the asymptotic 1-nearest neighbor risk, we imagine we have infinity observations. The nearest neighbor will therefore be picked out of a bag at random. In the area where the two classes overlap, there is a 3/5 chance of getting class 0 and a 2/5 chance of getting class 1. The risk is the expected loss, in the descrete case we sum over all the possiblities, multiplied by their probability, to get the expectation:

$$
\begin{aligned}
\mathbb{E}(L_{1-nn}) &= \sum_{x} L(x)p(x) \\
\mathbb{E}(L_{1-nn}) &= \sum_{x \in L(x) \neq 0} L(x)p(x) \\
\mathbb{E}(L_{1-nn}) &= 1 * \eta(x)(1-\eta(x)) + 1 * (1-\eta(x))\eta(x) \\
\mathbb{E}(L_{1-nn}) &= 2\eta(x)(1-\eta(x)) \\
\mathbb{E}(L_{1-nn}) &= 2(\frac{2}{5})(\frac{3}{5}) \\
\mathbb{E}(L_{1-nn}) &= \frac{12}{25}
\end{aligned}
$$

6

7