



## Why

We can summarize the (label, prediction) pairs for a particular classifier on a particular dataset in a matrix.

## Boolean case

Let  $A$  be a nonempty set and  $B = \{-1, 1\}$ . For a dataset  $(a^1, b^1), \dots, (a^n, b^n)$  in  $A \times B$ , and classifier  $G : A \rightarrow B$ , the *confusion matrix*  $C$  is defined

$$C = \begin{bmatrix} \# \text{ true negatives} & \# \text{ false negatives} \\ \# \text{ false positives} & \# \text{ true positives} \end{bmatrix} = \begin{bmatrix} C_{\text{tn}} & C_{\text{fn}} \\ C_{\text{fp}} & C_{\text{tp}} \end{bmatrix}.$$

Using this notation,  $C_{\text{tn}} + C_{\text{fn}} + C_{\text{fp}} + C_{\text{tp}} = n$ .  $N_{\text{n}} := C_{\text{tn}} + C_{\text{fn}}$  is the number of negative examples.  $N_{\text{p}} := C_{\text{fn}} + C_{\text{tp}}$  is the number of positive examples.

The diagonal elements of the confusion matrix give the numbers of correct predictions. The off-diagonal entries give the numbers of incorrect predictions for the two types of errors (see **Classifier Errors**).

In this notation, the false positive rate is  $C_{\text{fp}}/n$ , the false negative rate is  $C_{\text{fn}}/n$  and the error rate is the sum of these,  $(C_{\text{fn}} + C_{\text{fp}})/n$ .

The true positive rate is  $C_{\text{tp}}/(C_{\text{fn}} + C_{\text{tp}})$ . The true negative rate is  $C_{\text{tn}}/(C_{\text{tn}} + C_{\text{fp}})$ . The false alarm rate is  $C_{\text{fp}}/(C_{\text{tn}} + C_{\text{fp}})$ . The precision is  $C_{\text{tp}}/C_{\text{tp}} + C_{\text{fp}}$



