**Why**

How should we compare two classifiers?

**Definitions**

Let $a^1, \ldots, a^n$ in $A$ be a dataset of inputs and $b^1, \ldots, b^n$ in $B$ be a dataset of labels. Let $G : A \to B$ be a classifier.

For each $i = 1, \ldots, n$, the classifier associates a prediction $G(a^i)$ with $a^i$. The prediction $G(a^i)$ is *correct* if $G(a^i) = b^i$ and *incorrect* (*wrong*, *error*) if $G(a^i) \neq b^i$. The *error rate* is the proportion of the dataset for which the classifier's prediction is an error. In other words, $1/n \left| \{ i \mid G(a^i) \neq b^i \} \right|$.

Given two classifiers, it is natural to prefer the one with the lower error rate. Given that these two are the results of different inductors applied to the same, we can use a separate dataset to *validate* these.

**Boolean case**

In the case that $B = \{-1, 1\}$, we call the class $-1$ *negative* and the class $+1$ *positive*. Similarly, we call an example $(a^i, b^i)$ a *negative example* if $b^i = -1$ and a *positive example* if $b^i = 1$.

We call the result of $G$ on $a^i$ a *true positive* if $b^i = 1$ and $G(a^i) = 1$, a *true negative* if $b^i = -1$ and $G(b^i) = -1$, a *false negative* (or *type II error*, read "type two error") if $b^i = 1$ and $G(a^i) = -1$ and a *false positive* (or *type I error*, read "type one error") if $b^i = -1$ and $G(a^i) = 1$.

The *false positive rate* (*false negative rate*) of a classifier on a dataset is the proportion of dataset elements for which it predicts a *false positive* (*false negative*).

The *true positive rate* (or *sensitivity*, *recall*) of $G$ on a dataset is the proportion of positive examples which $G$ labels positive. The *precision* (or *positive predictive value*) of $G$ is the proportion of all examples which the classifier labels *positive* whose label is positive. The *true negative rate*

(or *specificity*, *selectivity*) is the proportion of negative examples which $G$ labels negative. The *false alarm rate* is the proportion of negative examples which $G$ *incorrectly* labels positive.

Classifier Errors

Classifiers

Predictors    Factorials

Sequences    Natural Products

Lists    Natural Sums

Set Numbers    Direct Products

Finite Sets    Recursion Theorem

Equivalent Sets

Function Inverses    Natural Order    Family Unions and Intersections

Function Composites    Function Images    Peano Axioms    Families

Equivalence Relations    Functions

Relations    Natural Induction

Set Products

Set Powers    Natural Numbers    Generalized Set Dualities

Partitions    Unordered Triples    Successor Sets    Intersection of Empty Set    Set Dualities    Set Unions and Intersections

Ordered Pairs    Set Intersections    Pair Unions    Set Complements

Set Unions    Set Differences    Pair Intersections

Unordered Pairs    Empty Set

Set Specification

Set Equality

Set Inclusion

Standardized Accounts

Accounts

Deductions

Quantified Statements

Logical Statements

Statements

Identities    Sets

Names

Letters    Objects

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