ML Section 1.4: Evaluation of Supervised Learning

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1 Hypothesis Evaluation

General questions:

- How can one estimate the performance of a learned hypothesis on future data?
- How good is the estimate?
- Comparative performance evaluations.

Formally: Given a hypothesis h and a data sample containing n examples drawn at random according to the distribution D, what is the best estimate of the accuracy of h over future instances drawn from the same distribution? What is the probable error in this accuracy estimate?

2 Evaluation Problems

- Limited samples of data may be misleading (e.g. prime numbers and data set = {3,5,7} leads to hypothesis of odd numbers).

- Observed accuracy on training data is often too optimistic (e.g. due to overfitting).
- Solution: use independent test examples.
- Problem: estimate may still depend on the specific makeup of the set of training/test examples.

3 Preliminary Definitions:

f The target customisation function to be learned (f:Examples $\rightarrow$ Categories).

h The hypothesis learned (h: Examples $\rightarrow$ Categories).

S Data sample of size n.

D Probability distribution over all data points.

Sample Error

$$error_s(h) = \frac{1}{2} \sum_{x \in S} \delta(f(x), h(x) \tag{1}$$

Where:

$$\delta(y, z) = 1 \text{ if } y \neq z, \text{ and } 0 \text{ otherwise.} \tag{2}$$

True Error

$$error)D(h) = Pr_{x \in D}[f(x) \neq h(x)] \tag{3}$$

4 Confidence Intervals