On Gambling and Learning

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Abstract

In this note the authors discuss the link between gambling and learning.

In a simple setup, a gambling process [1] proceeds as follows. One "predicts" or states that the outcome of a random experiment will be so and so, the experiment is run, and if the outcome matches the stated outcome, the predictor earns a handsome amount of money or reward. If there is a mismatch, there is no reward and one gets another chance at prediction. This loop continues for say a maximum of N iterations. The goal is to maximize the rewards gained.

Now consider training a perceptron [2]. The perceptron is in some initial state. Data from a random experiment is fed into it, and the perceptron provides an output. If the output matches the expected output, the perceptron is said to have succeeded in classification. If there is a mismatch, the distance between the expected output and the perceptron's actual output is used to "update" the perceptron's state and fresh data is fed into it. The process continues in this vein, for a total of N iterations. The goal is to minimize the sum of the distances between the expected and the actual outcomes of the iterations. A trained perceptron has "learned" the relation between input and desired output, or, it has learned the desired input-output map.

Clearly, the parallels are obvious. For example, in both settings there is a loop. In both settings, there is either a minimization or a maximization of a per-iteration quantity. It would not be surprising if the two processes can be considered as duals of one another in a formal sense, or, even more optimistically, equivalent. In the latter scenario, one could say, "to learn is to gamble."

The other direction, saying, "to gamble is to learn," is rather obvious. For in gambling as described herein, one is learning about the random process enough so that one's rewards are maximized. This may be the desired link between these two fundamental fields. In future work, we hope to extend this classical connection to the quantum realm, defining "quantum gambling processes."

References

[1] Thomas M. Cover and Joy A. Thomas. *Elements of Information Theory.* 2005.

[2] Simon Haykin. *Neural Networks and Learning Machines, 3/E.* Pearson Education India, 2010.