Journal of Statistical Physics, Vol. 105, Nos. 3/4, November 2001 (© 2001)

Book Review: *Statistical Mechanics of Learning*

Statistical Mechanics of Learning. A. Engel and C. Van den Broeck, Cambridge University Press.

This thorough and professional book describing in detail the contribution of statistical physics to learning theory as it has been applied to neural networks during the past decade. Its major theme is the extension of the techniques developed for random magnetic systems, such as the replica method, to obtain quantitative results for the computational capabilities of various feedforward networks.

The emphasis is on the derivation of quantities such as the storage capacity and the generalization error for learning a rule from examples in various feedforward architectures and learning scenarios. The observation that networks can learn from examples and are able to extract an underlying rule, offers an appealing alternative to program-driven systems when an efficient algorithm is difficult to find.

A major part of the book deals with the perceptron. On the one hand its computational capabilities are very limited, but on the other hand it is simple enough that all of its properties and the application of learning theory to it can be discussed and presented in detail. Only Chaps. 12 and 13 go beyond the perceptron.

Chapters 12 and 13 deal with properties of multilayer networks, and the book concludes in Chap. 14 with a brief description of other complex problems arising outside of physics, such as error correcting codes and game theory, that can be analyzed using methods of statistical mechanics. This way of presenting the concepts and the analytical tools contributes very much to the book's readability.

One of the main analytical tools used throughout the book is the replica method. The detailed calculations and the comprehensive explanations, accompanying the derivation of the results, are beyond those to be found in the original literature. This is an excellent textbook from which to learn the replica method, including the technique of replica symmetry breaking and its application to other complex problems.

0022-4715/01/1100-0719$19.50/0

The only chapter missing is one on the development in the statistical mechanics of learning during the past decade to time-series prediction.

I would suggest that the authors add selected solutions (or a guideline to the solutions) for the sets of problems appearing at the end of each chapter in a future revision.

My overall impression is that this is an excellent textbook on the statistical mechanics of learning, enhanced by many examples and exercises. The book will be useful as a guideline for both graduate courses and for self-teaching, and as such is a welcome and much needed addition to the literature on neural networks and learning theory in general.

Ido Kanter
Department of Physics
Bar-Ilan University
Ramat-Gan, 52900
Israel