

Book Review, *Network: Computation in Neural Systems* 7, 151 (1996)

Paul John Werbos, *The roots of backpropagation. From Ordered Derivatives to Neural Networks and Political Forecasting*, J. Wiley & Sons, New York (1994).

The original 1974 Harvard doctoral dissertation of Paul Werbos "Beyond regression" takes about three quarters of this book. Four papers written between 1981 and 1993 comprise the rest. The dissertation has been republished 20 years after it has been written because of its historical significance: it contains the original backpropagation algorithm, presented by the author as a general method applicable to any ordered (feedforward) nonlinear system, not only artificial neural networks.

Backpropagation, or "dynamic feedback" as Werbos calls it, was developed as an improvement over statistical methods for prediction and decision taking in social science, politics, history and economics. The main thesis advisor, Prof. Karl Deutsch, was a political scientist and it was in the context of Deutsch-Solov model of social assimilation that the systematic way of calculation of derivatives, the basis of backpropagation, was introduced (I wonder where in Europe, except maybe in the UK, would such a thesis be possible). Neural networks are explicitly mentioned in the 1981 paper by Werbos on the nonlinear sensitivity analysis. A short tutorial reprinted from the 1990 issue of the *Proceedings of the IEEE* presents a simple introduction to modern backpropagation techniques, including its extensions to backpropagation through time and to recurrent networks. A chapter on neurocontrol contains general introduction to the field and the final chapter discusses relations between neural networks, the brain seen as a neurocontroller, and the human mind.

It is the breadth of the book, not only its historical value, that makes it an interesting and worthwhile reading. The great popularity of neural networks resulted mainly from technical applications. In his thesis and papers Werbos goes much further, discussing not only technical issues and applications, but also decision making in military history, mathematical and verbal models in social sciences, even inspirations from Freud's idea of "psychic energy flow" that were important motivation factor for development of backpropagation approach! This book should be read as an antidote to purely technical books dominating the neural network field.

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