

Preface

This book is concerned with theoretical aspects of the affine projection algorithm (APA). The APA is a natural generalization of the classical, normalized least-mean-squares (NLMS) algorithm. It exploits multiple regressors for updating the coefficients of an adaptive filter, while the NLMS algorithm uses only the current, single regressor. The APA improves the convergence rate of an adaptive filter over the NLMS algorithm, especially for correlated input signals. By adjusting the number of regressors used, one can make a trade-off between the convergence rate and the computational complexity.

After the birth of the APA in the middle of the 1980s, several adaptation algorithms that also exploit multiple regressors were put forward independently. Most of them are now recognized as variants of the APA, constituting a family of APAs. Subsequently, many efforts were made to investigate the convergence behavior of the APA. We have also seen developments of techniques to reduce the computational complexity of the APA. Furthermore, we now have the kernel APA (KAPA), which extends the APA by the kernel trick so that it is applicable to identification of nonlinear systems. Recently, variable parameter APAs of various kinds are being studied. In this way, a tiny seed planted around 30 years ago has now grown, cherished by many researchers, into a big tree with lots of branches. The publication of this book was motivated by such a situation.

The book traces the above-mentioned history of development of the APA. In introducing the APA, the idea of affine projection, from which the name of the algorithm comes, plays an essential role. Actually, the APA emerged from the affine projection interpretation of the NLMS algorithm. Such a geometrical view enables us to see many of the important properties of the APA. Thus, to understand the principle of the APA, Chap. 3 is most fundamental.

I have tried to make the book self-contained and the mathematical proofs easily traceable by the reader as much as possible. The prerequisite is an elementary knowledge of calculus, linear algebra, probability, and statistics. Mathematical facts that can be described independently of the main body of the book are mostly put into appendices for readability. Since the theory of the APA relies on diverse

mathematical materials, this made the appendices, especially in Chap. 3, unusually voluminous.

The APA is still developing. Computational problems will be overcome with the advancement of algorithms and digital technology. I hope this book will give a perspective of the APA world, and provide a basis for its further development.

In writing this book, I benefited from numerous papers that contributed to the development of the APA. Many parts of the book are reviews of those contributions. I wish to thank the authors of those papers. My thanks also go to the staff of Springer Japan, for their unfailing courtesy, encouragement, and help.

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