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Neural Networks and Sea Time Series

*Reconstruction and
Extreme-Event Analysis*

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Preface

This book describes the results of a successful collaboration between a group at the Department of Physics of Rome University “La Sapienza” and a group of engineers who for many years have been engaged in researching marine events at the National Department of Technical Services of Italy (“Dipartimento dei Servizi Tecnici Nazionali, DSTN, now APAT, Agency of Environmental Protection and Technical Services). From the time when mankind first took to the sea, the possibility of creating safe and secure marine constructions has given rise to the need to monitor the complex phenomenology of the sea’s evolution. Our group of physicists has a lot of experience in the utilization of artificial neural networks (ANN) in many different fields and has always had the feeling that many improvements could result from their applications. On the other hand, the engineers have a specific problem in dealing with the long time series of sea data, which are necessary for security estimates and improving the applications. The exchange among the two groups led to the conclusion that this problem, together with many others described in this book, could be solved by the application of ANN.

The particular problem that we take as our starting point is the reconstruction of missing data, a general problem that appears in many situations of data analysis, although the solution obtained with the application of ANN was reasonably good, albeit unexpected. This fruitful attempt is one of the first applications of ANN to time series of sea data that we know of. We hope that this promising beginning will encourage researchers in the field to continue to develop such an approach to similar problems.

Since this is one of the first experiences in this field, we feel that it is useful and important to describe in detail how one can use ANN, a flexible but complex instrument, and also to explain the theory behind it. At the same time it is necessary to show the complex problems posed by sea events and their phenomenology in order to understand exactly what we have to investigate. One of the main steps in the application of ANN is to have a sure sense of the problem to be dealt with. Otherwise, even a good technical knowledge of the algorithm is useless. This book therefore includes both the theory and practice involving these two fields. It is written in such a way that nonexperts in both fields can understand it. We hope that this presentation

may encourage readers to try an analogous approach in other useful applications. In particular, we want to emphasize that the study on the sea time series measured along the Italian coasts presented in this book can be easily repeated and generalized to other coasts and seas. We give an example of this in Chapter 10, where we analyze the same problems and solutions relative to the sea heights and levels around the coast of California.

We thank Professor Sergio Albeverio and Professor Antonio Speranza for many useful discussions and their careful reading of the manuscript.

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Silvia Puca
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Sara Morucci
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*Neural Networks
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Sea Time Series*