Machine Learning Methods in the Environmental Sciences: Neural Networks and Kernels

By William W. Hsieh

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Machine learning methods originated from artificial intelligence and are now used in various fields in environmental sciences today. This is the first single-authored textbook providing a unified treatment of machine learning methods and their applications in the environmental sciences. Due to their powerful nonlinear modelling capability, machine learning methods today are used in satellite data processing, general circulation models(GCM), weather and climate prediction, air quality forecasting, analysis and modelling of environmental data, oceanographic and hydrological forecasting, ecological modelling, and monitoring of snow, ice and forests. The book includes end-of-chapter review questions and an appendix listing web sites for downloading computer code and data sources. A resources website containing datasets for exercises, and password-protected solutions are available. The book is suitable for first-year graduate students and advanced undergraduates. It is also valuable for researchers and practitioners in environmental sciences interested in applying these new methods to their own work.

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Editorial Review

Review
'... one of the first books describing machine learning techniques in the context of environmental applications ... goes a long way in explaining these subjects in a very clear, concise, and understandable way. This is one of the few books where one will find diverse areas of machine learning all within the same cover ... aimed at advanced undergraduates and PhD students, as well as researchers and practitioners. No previous knowledge of machine learning concepts is assumed.' Vladimir Krasnopolsky, National Oceanic and Atmospheric Administration (NOAA) and National Weather Service

'[This book] aims to, and succeeds in, bridging the gap between AI and what is often referred to as conventional statistics. Add to that the unique perspective that a physicist and an environmental scientist brings to the table, and one has a truly rare book. ... a well-balanced mix of theoretical and practical exercises. ... Hsieh's book [is] ideal as both a textbook on the topic, and a reference book for the researcher in the field.' Caren Marzban, University of Washington and University of Oklahoma

'The material is explained in a straightforward, clear, concise, and complete manner. The reader does not have to wade through lengthy explanations and can proceed quickly. All relevant topics are covered from historical to very recent. The full mathematical equations are presented for every topic so the reader may fully appreciate the theory and concepts discussed. Numerous diagrams are included, and are of great utility for explaining complex material and concepts. All of the main facets of machine learning are covered, including theory, data selection, data reduction and data clustering, and problems of overfitting and underfitting data.

This book is unique because it presents machine learning in the context of environmental science applications. I found it to be a valuable tool to bring myself up-to-date with the historical and recent developments in the subject of machine learning, and I believe the reader will too. The purchase price is modest. I highly recommend that any student or researcher interested in machine learning methods obtain a copy.' The material is explained in a straightforward, clear, concise, and complete manner. The reader does not have to wade through lengthy explanations and can proceed quickly. All relevant topics are covered from historical to very recent. The full mathematical equations are presented for every topic so the reader may fully appreciate the theory and concepts discussed. Numerous diagrams are included, and are of great utility for explaining complex material and concepts. All of the main facets of machine learning are covered, including theory, data selection, data reduction and data clustering, and problems of overfitting and underfitting data.' CMOS Bulletin

About the Author
William W. Hsieh is a Professor in the Department of Earth and Ocean Sciences and in the Department of Physics and Astronomy, as well as Chair of the Atmospheric Science Programme, at the University of British Columbia. He is internationally known for his pioneering work in developing and applying machine learning methods in environmental sciences. He has published over 80 peer-reviewed journal publications covering areas of climate variability, machine learning, oceanography, atmospheric science and hydrology.

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