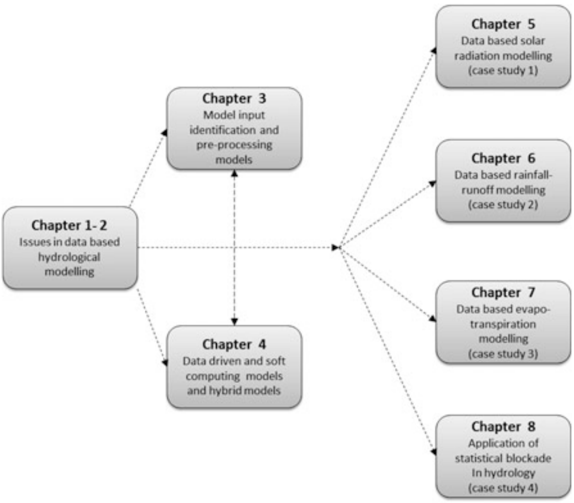
Preface

A hydrological system is highly complex in nature with all processes within the system constituting dynamic and nonlinear interaction of several variables. Data-based soft computing techniques are emerging in the field of hydrology since the last couple of decades. Various developments in the recent data-driven soft computing models have shown their immense modelling capabilities amidst scarce and erroneous input space, such as models that are tolerant to imprecise and uncertain inputs. The notion and success of data-driven models depend on their learning capability from the given data set and on their capability to translate to useful information. Despite the growing advancements in data-driven approaches in hydrology, there are concerns on points like multi-collinearity, input selection, training data length selection, required data frequency for best modelling, model complexity control and modelling extreme values.



The aim of this book is a comparison of a number of state of art and traditional input selection approaches and specific data-driven models in different case studies considering the above-mentioned data-driven issues in hydrology. The structure of the book is as follows: Chap. 1 introduces modelling concepts and provides a review of data-driven modelling in modelling themes like rainfall-runoff dynamics, solar radiation and evaporation modelling. Chapter 2 starts with a brief detail of hydroinformatics and then addresses some of the data-based modelling issues in hydrology. This chapter reminds the need to evaluate existing hypothetic assumptions on various data-driven models including ANNs. Chapter 3 briefly discusses various novel approaches in data selection methods. The novel approach called the Gamma Test is described along with other mathematically sound techniques like Entropy Theory, Cluster Analysis, PCA, BIC and AIC. Towards the end of this chapter conventional data splitting and correlation approaches are described for the totality of the chapter. Chapter 4 includes details of data-driven artificial models and hybrid forms of these models that are intensively used in the field of hydrology, environment and other earth sciences. The chapter also describes conventional artificial intelligent techniques to investigate different aspects of the hydrological cycle. Conventional linear data-based techniques like ARX and ARMAX are described in the early part of the chapter. Following that, traditional ANN architecture is described along with different training algorithms adopted in this book for modelling. This chapter also deals with three other major nonlinear modelling techniques like Adaptive Neural Fuzzy Inference Systems (ANFIS, Support Vector Machines (SVMs) and Local Linear Regression (LLR). Discrete wavelet transforms (DWT) and its hybrid forms with ANNs, ANFIS and SVMs are briefly described.

Chapters 5–7 are case studies which incorporate all concepts and approaches described in Chaps. 2–4. Chapter 5 deals with a case study on data-based modelling on solar radiation estimation. This chapter draws different comparisons of working in data selection approaches (Gamma Test, Entropy theory, AIC (Akaike's information criterion) / BIC (Bayesian information criterion)) in solar radiation modelling. The modelling outputs of the proposed models and conventional models are discussed in detail after comparison with the observed measurements. The chapter deals with operations and applications of Conjugate Gradient ANNs and Levenberg–Marquardt ANNs along with other higher degree data-based models (ANFIS, SVM, wavelet hybrid models). Similar investigation is carried out in Chap. 6 in which the case study theme is rainfall-runoff modelling. This chapter also illustrates input redundancy checking and identifies the best data interval for rainfall-runoff dynamics modelling for the study region of the River Brue catchment. The next case study is evapotranspiration modelling; this is described in Chap. 7. In this theme we have tried to incorporate an analysis of different standard models of reference evapotranspiration along with data-based artificial intelligence models. The first few sections of this chapter are devoted to the results obtained from different Penman Montienth models in comparison with the newly proposed 'Copais Approach'. In later sections the results obtained from the data-based models are discussed in detail. We have also introduced a unique final chapter, Chap. 8, in which we introduce a novel Monte Carlo (MC) technique called Statistical Blockade (SB), which focuses on significantly rare events in the tail distributions of data space and modelling. A case study modelling from a Himalayan river basin is introduced and compared with the results from that of ANNs and SVM in this chapter.

Cranfield, UK Renji Remesan
Bristol, UK Jimson Mathew

http://www.springer.com/978-3-319-09234-8

Hydrological Data Driven Modelling
A Case Study Approach
Remesan, R.; Mathew, J.
2015, XV, 250 p. 172 illus., 59 illus. in color., Hardcover
ISBN: 978-3-319-09234-8