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Data Science for Wind Energy

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BOOK REVIEWS

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Data Science for Wind Energy by Yu Ding. Boca Raton, FL: CRC Press, Taylor & Francis Group, 2020, xx1+387 pp., $102.12, ISBN: 978-1-138-59052-6.

The world demand for energy is steadily increasing but the contributions of energy sources are continuously changing. There are several trends in energy development among the trends is change in energy types: from high- to low-carbon, or from fossil to non-fossil energy sources due to the world wide concern of the carbon foot-print and climate change. Other trends include the technological advances in energy production such as fracking, advances in solar power generation, and wind energy. Moreover, improving the efficiency of production processes as exemplified by the design of larger turbines that increase the energy production per turbine as well as improving the efficiency of the plant are major challenges in wind energy.

Data Science for Wind Energy addresses the production process of wind energy. The author's background and training in mechanical engineering and data analysis and modeling positioned him to develop accurate models for wind energy production, prediction, and efficiency.

There are many books and resources on "data science" written by authors from different disciplines including computer science, statistics, business, and engineering. Similarly, there is an equivalent list of books on wind energy. However, none exits that links the two areas. This book fills the gaps with strong physical and statistical models. The book begins by providing an

overview of wind energy, its importance and issues in predicting its output energy due to many sources of uncertainties. The following chapters provide forecasting models which can be applied for energy output and demand. The new contributions are in the spatio-temporal models where determination of wind directions and magnitude at different locations in wind energy "farms" is critical to the overall performance of the energy system. This is well explained and presented in Chapter 3 which focuses on covariance functions with application to wake effect in the energy systems, it contains interesting and useful statistical approaches such as kriging and Gaussian spatio-temporal autoregressive models which are then applied in local wind field taking into consideration the geometry of the wind turbine blades and other factors. The following chapter focuses on regime-switching approach where nonstationary processes (such as wind speed) is changed to stationary process (regime change) to be able to obtain computationally efficient models. This where "data science" is effectively applied.

This theme continues in the following chapters where power curve modeling and analysis are treated in-depth. The physical model of the wind turbine is incorporated to obtain realistic power curves. One of the most challenging aspects of the physical structures of the wind energy system is the maintenance and replacements of parts specially when operating under offshore environments or in large "wind" farms set up. Monitoring and prediction of failure times of the critical components is data-rich environment and the use of data science is effective in identifying failure modes and the failure times. These are carefully and clearly addressed in this book.

This is the first book that focuses on the data science methodologies and their applications in a growing field, wind energy. It is well-organized and well-written. It will enhance the knowledge base of data science and its applications in the wind energy field.

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The Information Theory of Comparisons, With Applications to Statistics and the Social Sciences by Roger Bowden. Singapore: Springer, 2018, xv+159 pp., ISBN: 978-981-13-1549-7.

The Information Theory of Comparisons, With Applications to Statistics and the Social Sciences is a very readable book presenting the information theoretic research developments for useful practical applications in Statistics and the Social Sciences. This book is a study in general statistical methodology and its application to areas in actuarial science, climatology, data analysis, demography, economics, education, finance, political science, psychology, and management science.

The book has seven chapters. Chapter 1 introduces the basic ideas of partition entropy and its relationship with classic Shannon entropy. Chapter 2 introduces the left and right entropic shifting of a given distribution and their relationship with partition entropy. Chapter 3 provides the development of the double smoothing process, consequent distributional metrics for spread and asymmetry and their relationship with Gini's mean absolute difference and stochastic dominance. Chapter 4 describes the interpretation and application of new metrics for asymmetry and spread in the areas of income distribution, stock market performance in finance, and actuarial science of survival and age distributions. Chapter 5 goes deeper into entropic complexity and its metric implications. Chapter 6 gives bivariate and multivariate extensions to the developments discussed in earlier chapters. Chapter 7 concludes with a broad ranging discussion on these important topics. Each chapter ends with a list of references.

I enjoyed reading this book and learned a lot from it. I strongly recommend it to anyone who would like to learn more about the area of information theory based inferences and their applications in social sciences.

Subir Ghosh
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Handbook of the Shapley Value by Encarnación Algaba, Vito Fragnelli, and Joaquín Sánchez-Soriano, editors. Boca Raton, FL: Chapman and Hall/CRC, Taylor & Francis Group, 2020, xxix+576 pp., $160.00, ISBN: 978-0-8153-7468-8.

This volume belongs to the series in *Operations Research*, and is devoted to the modern development and applications of the Shapley value—one of the most famous tools of the cooperative (non-antagonistic) game theory. It was introduced by Lloyd Shapley in 1953 (Shapley 1953), who together with his follower Alvin Roth (Roth 1988) won Nobel Prize in economics in 2012. Shapley value (let us denote it SV) uses a finite formula of combinatorial kind to assign a unique distribution among all the players who yield a total surplus in their coalition. In a brief lay explanation, the SV allocates the total value of the game to each player by evaluating over all possible coalitions that a player can join in. The value for an ith player can be defined as

$$\varphi_i = \sum_{S-\text{all subsets}} \gamma_{n(s)} \left[\upsilon(S) - \upsilon(S - \{i\})\right]$$

here the summing is taken across all possible subsets of players S. The function $v()$ is called a characteristic function defining a value of a coalition. The value of an ith player is defined via the averaged increments for all subsets of the value $v(S)$ of the game for a subset S containing player i from the value $v(S-\{i\})$ of that subset of players without the ith player. In other words, it is the marginal value of adding the player to any possible set of other players. The weights are defined as

$$\gamma_{n(s)} = \frac{(s-1)!(n-s)!}{n!}$$

so the summation is weighted by a factor that reflects the number of subsets of a particular size (s) that are possible given the total number of players (n).

The book opens with the foreword by A. Roth, and presents about 60 authors in 24 chapters of their contributed papers. The most of works describe developments achieved in Spain and several other European countries. In the Preface, the editors describe the book structure in four parts: the first Chapters 1 and