

---

## Preface

Scientific and technological developments in any discipline have become heavily dependent on the digital data treatment for better and refined deductions from available time series records that reflect the behavior of natural phenomena or artificial events as for their performances. These phenomena and events are rather complex, uncertain at times, vague, and even incomplete in their past records, which are also embedded with some deterministic components such as linear or nonlinear trends, sudden jumps, and seasonalities, each of which provide useful information for prediction of the future behavior so as to be able to control the natural events to a certain extent. Especially, trend component is the most sought one, because it shows the direction of general tendency within the partially uncertain events and especially since four decades their search has become a very significant task concerning climate change effects on environmental, social, and health aspects; economic growth indices; business affairs; and industrial production quality controls.

Currently, there is a trend in automation and data exchange in manufacturing technologies that leads to a new paradigm shift in industry that is now referred to as the Industry 4.0, which will be empowered only with innovative methodological procedures. Trend identification, determination, future extension, and de-trending procedures will gain refined and progressive advancement that will pave way towards better management and control of the phenomenon concerned in scientific, technological, engineering, environmental, social, economic, business, and health aspects. The success of industrial machines to predict failures and trigger maintenance processes autonomously or self-organized logistics, which react to unexpected sudden changes (jumps) or gradual and monotonic expected changes in the behavior of the phenomenon or production concerned. In order to arrive at meaningfully guiding information, it is necessary to provide useful insight into the prediction and management procedures through data processing by means of innovatively advanced analytical approaches and algorithms. The information generation algorithms should be able to detect and address visible and hidden issues in environmental changes such as the climate change impacts on different disciplines, machine degradations, depreciations, or improvements in the final industrial production.

In order to achieve effective prediction, management, and information generation, one of the most important data processing issues is the identification and determination of trend component in a given record especially in the form of time series. This is the main purpose of this book where after an effective literature review in the first three chapters different types of innovative trend analysis methodologies are presented in the science philosophical, logical, rational, and linguistic foundation leading to the probabilistic, statistical, and stochastic aspects for better and refined trend identification. The innovative trend template provides first of all visual inspection for verbal information deductions not only for holistical purposes, but also for providing better views in terms of at least three categories as “low,” “medium,” and “high” record values within the data. Spatial and partial trend component identification methodologies are also provided with simple but illuminating examples. Innovative trend simulation studies and trend test statistical procedures are explained along with actual example applications from different parts of the world. Apart from the classical trend analysis on the average, possible trend behavior in terms of standard deviation is also presented with innovative approaches under the title of variability. Last but not least, after a brief explanation of fuzzy logic modeling principles, fuzzy trend analysis fundamentals are explained. In the final chapter, several examples are presented concerning the climate change impact in terms of trend analyses.

The content of this book is an outcome from a series of lectures by the author at the Technical University of Istanbul and also at the King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia. Furthermore, many aspects of the trend analysis have been discussed with international students from different countries personally and through the electronic communication systems. I appreciate all of these precious discussions, which accumulated and led to the production of this book. It will give me pleasure and self-satisfaction if the content of this book serves to those who are interested in the trend analysis.

In writing an international book one has to be very patient and confine his/her attention for many hours, days, months, and even years without care for many other things and therefore needs the support of many others. I appreciate and thank those who have encouraged me to write this book and at the top of the list is my wife Mr. Fatma Şen for her endurance, patience, and encouragement.

Çubuklu, Istanbul, Turkey  
2016

Zekâi Şen

Innovative Trend Methodologies in Science and  
Engineering

Şen, Z.

2017, XIII, 349 p. 163 illus., 51 illus. in color., Hardcover

ISBN: 978-3-319-52337-8