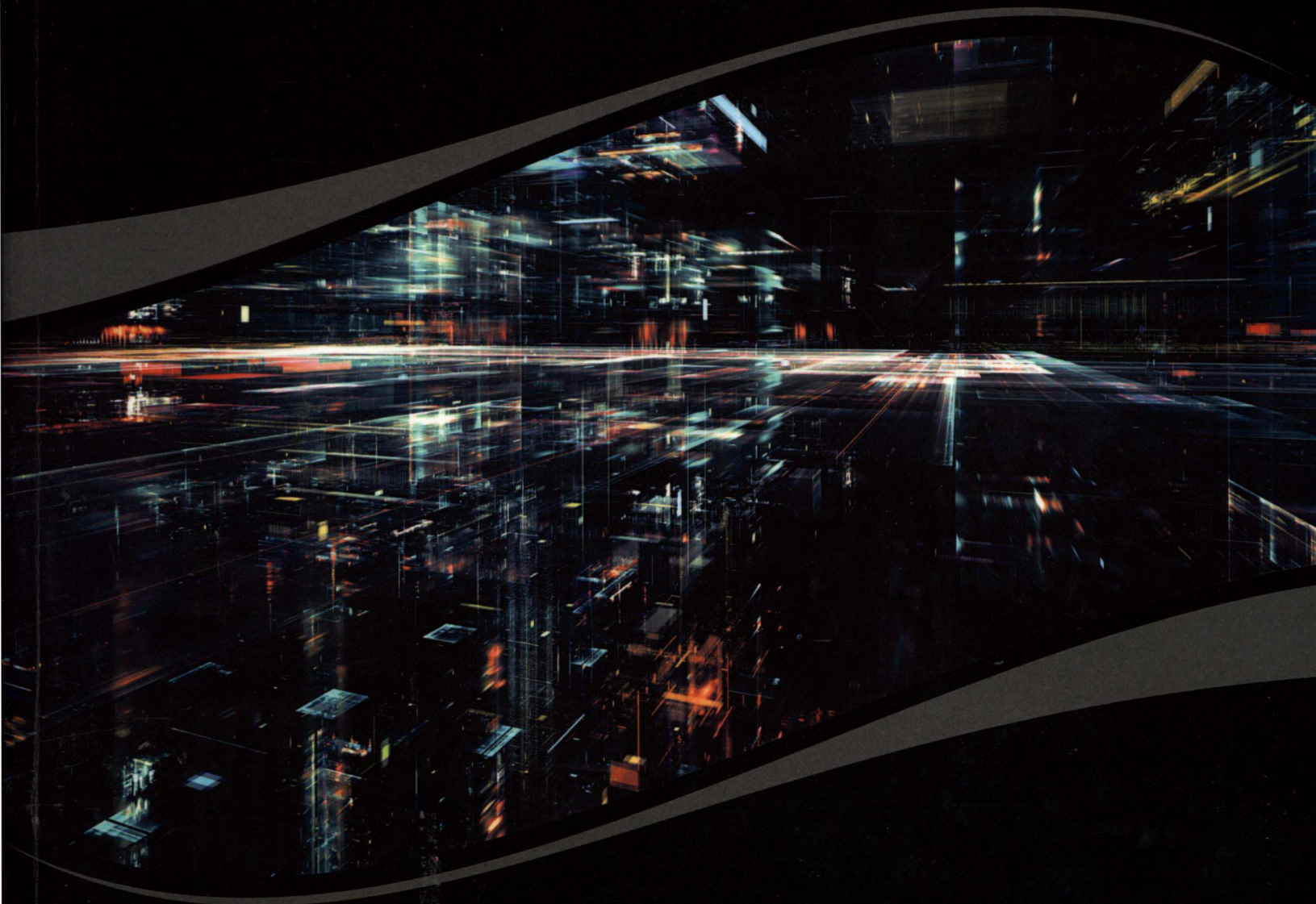


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Global Trends in Intelligent Computing Research and Development



B.K. Tripathy and D.P. Acharjya



Global Trends in Intelligent Computing Research and Development

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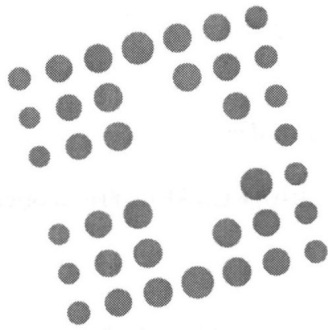
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Preface

The vast amount of data collected by different organizations all over the world across a wide variety of fields today has no utility unless these are analyzed to get useful information. This necessitates the development of techniques that can be used to facilitate the process of analysis. The development of powerful computers is a boon to implement these techniques leading to automated systems. The transformation of data into knowledge is by no means an easy task. Moreover, these data may involve uncertainty in many different forms. Many different models, like fuzzy sets, rough sets, soft sets, neural networks, their generalizations, and hybrid models obtained by combining two or more of these models, have been found to be fruitful in representing data. These models are also very fruitful for analysis. More often than not, the high dimensional data are reduced to include only the important characteristics necessary from a particular study point of view or depending upon the application area. Therefore, reduction techniques have been developed. Often, the data collected have missing values. These values need to be generated or the tuples having these missing values are eliminated from the data set before analysis. The later approach sometimes leads to loss of information and hence not preferred.

Our intention in editing this book is to offer concepts and methods of knowledge representation and computational intelligence in a precise and clear manner to the research community. In editing the book, our attempt is to provide frontier advancements in knowledge representation and computational intelligence, the conceptual basis required to achieve in depth knowledge in the field of computer science and information technology. It will help those researchers who have interest in this field to keep insight into different concepts and their importance for applications in real life. This has been done to make the edited book more flexible and to stimulate further interest in topics.

The topics to be discussed are theoretical foundations of computational intelligence, knowledge representation, and computational intelligence for knowledge representation. Hybrid intelligent techniques and real life applications that give stress on the basic knowledge on computational techniques; its development stages to present day technology is also discussed in different parts of the edited book. These parts will broadly be distributed over the topics rough sets, fuzzy sets and neural network, knowledge discovery in databases, data mining, soft set, genetic algorithm, soft computing, and their applications in real life situations.

Knowledge representation is a sub area of Artificial Intelligence concerned with understanding, designing, and implementing ways of representing information in computers so that programs (agents) can use this information to derive information that is implied by it, to converse with people in natural languages, to decide what to do next to plan future activities, and to solve problems in areas that normally require human expertise. Deriving information that is implied by the information already present is a form of reasoning. Knowledge representation schemes are useless without the ability to reason with them.

Data mining automates the process of finding predictive information in large databases. Questions that traditionally required extensive hands-on analysis can now be answered directly from the data quickly. A typical example of a predictive problem is targeted marketing. Data mining uses data on past promotional mailings to identify the targets most likely to maximize return on investment in future mailings. Other predictive problems include forecasting bankruptcy and other forms of default and identifying segments of a population likely to respond similarly to given events. The most commonly used techniques in data mining such as artificial neural network, decision trees, genetic algorithm, nearest neighbor method, evolutionary algorithms, and rule induction will be stressed.

The book is comprised of four sections. The first section is an attempt to provide an insight on classification and clustering. It presents variety of real life applications based on classification and clustering. The second section discusses theoretical foundations on knowledge representation, and section three provides information on computational intelligence. The final section discusses information science and application of neural network in bio-sciences. Each section provides the current research trends in the concerned field of study.

Optimal inventory prediction is one of the important issues faced by owners of retail chain stores. Determination of how, when, and what quantities of products are to be reordered is a key to running a profitable business. Several attempts have been made to develop a generic forecasting model for accurate inventory prediction for all products. In chapter 1, progression analysis technique is used, which reveals that most of the stable products of successive years come from the list of stable products of previous years. It is concluded that clustering driven stability analysis can be used as one of the handy tools for better inventory prediction.

The purpose of segmentation is to detect relevant and meaningful data by means of removal of redundancy embedded therein. Image segmentation is one of the major application areas of segmentation as it is a process of segregating an image space into multiple non-overlapping meaningful homogeneous regions (i.e. pixels of each region are homogeneous to each other with respect to some characteristics whereas the union of any two regions is not). The 2nd chapter is concerned with the segmentation of true color images and is aimed to segment true color images into a different number of classes with help of the optimized class boundaries for individual color components. The proposed genetic algorithm-based optimization techniques has been applied to generate these color components in parallel.

Soft Computing techniques generally refer to the techniques, which use some method of search to solve the problem. It differs from conventional computing in that it is tolerant of imprecision, uncertainty, partial truth, and approximation. It also refers to techniques, which mimic the methods used by human beings and animals. Some of the soft computing techniques are evolutionary computation, neural networks, particle swarm optimization, ant colony optimization, and fuzzy computing. Chapter 3 provides specific applications where the techniques mentioned above have been used. The applications are in the fields of supervised and unsupervised learning, namely classification and clustering have been discussed.

Chapter 4 presents a Quantum Inspired Genetic Algorithm (QIGA). The QIGA adopted the inherent principles of quantum computing and has been applied on three gray level test images to determine their optimal threshold values. Quantum random interference based on chaotic map models and later quantum crossover, quantum mutation, and quantum shift operation have been applied in the proposed QIGA. The basic features of quantum computing like qubit, superposition of states, coherence and decoherence, etc. help to espouse parallelism and time discreteness in QIGA. Finally, the optimum threshold value has been derived through the quantum measurement phase. In the proposed QIGA, the selected evaluation metrics are Wu's algorithm, Renyi's algorithm, Yen's algorithm, Johannsen's algorithm, Silva's

algorithm, and finally, Linear index of fuzziness and the selected gray level images are Baboon, Peppers and Corridor. The conventional Genetic Algorithm (GA) and Quantum Evolutionary Algorithm (QEA) proposed by Han et al. have been run on the same set of images and evaluation metrics with the same parameters as QIGA. Finally, the performance analysis has been made between the proposed QIGA with the conventional GA and later with QEA proposed by Han et al. that reveals its time efficacy compare to GA along with the drawbacks in QEA.

As computer and database technologies advance rapidly, data accumulates at a speed unmatched to human's capacity of data processing. Data mining as a multidisciplinary topic obtained from databases, machine learning, and statistics is efficient in transforming mountains of data into nuggets. Researchers and practitioners realize that, to use effectively data mining tools, data pre-processing is highly essential. Feature selection or dimensionality reduction is one of the important and frequently used techniques in data pre-processing for data mining and bio-informatics applications. In contrast to other dimensionality reduction techniques, feature selection techniques preserve the original semantics of the variables, hence offering the advantage of interpretability by a domain expert. Feature selection has been a fertile field of research and development since 1970s in statistical pattern recognition, machine learning, and data mining, and is widely applied to many fields such as text categorization, image retrieval, customer relationship management, intrusion detection, and genomic analysis. The main objective chapter 5 is to make researchers aware of the benefits, and in some cases even the necessity of applying feature selection techniques in Bioinformatics domain, highlighting the efforts given by the bioinformatics community in developing novel and adapted procedures.

There is an urgent need for a more effective methodology to understand, prevent, and cure cancer. Microarray technology provides a useful basis of achieving this goal, with cluster analysis of gene expression data leading to the discrimination of patients, identification of possible tumor subtypes and individualized treatment. Chapter 6 provides a survey of significant developments in this direction in order to prevent cancer.

Chapter 7 discusses the hybridization of fuzzy techniques with genetic algorithms, which is very fruitful in many application areas. Multiobjective optimization is also another recent technique instead of single objective optimization because of its utility in real life scenario. In this chapter, multi-objective genetic-fuzzy association rule mining approaches and multi-objective genetic-fuzzy approaches in associative classification have been presented and some of the application areas of this approach have been discussed.

Ever since their inception, rough sets have been found to be a fruitful model to capture imprecision in data and have many useful applications in different fields including computer science. Equality of sets in the mathematical sense is too stringent to be applied in real life situations. Most importantly, it does not include user knowledge in deciding the equality of two sets. In order to incorporate user knowledge in deciding the equality of two sets, Novotny and Pawlak used rough sets to define a set of approximate equalities. By adding three more types of rough set-based approximate equalities, Tripathy et al. studies it further and extended these notions to study the approximate equalities of fuzzy sets, intuitionistic fuzzy sets also. Further, the same has been extended to generalize rough set models like covering based rough sets and multigranular rough sets. In chapter 8, all the notions of approximate equalities have been presented in chronological order; several properties of all these notions have been presented and their applicability is discussed with suitable examples and comparative analysis. Approximate reasoning is an integral part of human reasoning in day to day live. The notion of approximate reasoning has been discussed using the notions of approximate equalities and is reflected in all the real life examples provided.

Case-Based Reasoning (CBR) is an offspring of research into cognitive science starting with the work of Prof. Roger Schank and his students at Yale University. CBR may be defined as a model of reasoning that incorporates problem solving, understanding and learning, and integrates all of them with memory processes. CBR is a general Artificial Intelligence paradigm for reasoning from experience, and learning from problem solving. It involves analogical reasoning, problem solving, and experimental learning. Chapter 9 provides basic idea of case-based reasoning, with an eye on its up to date status and its applications. This chapter will be useful to researchers in computer science, electrical engineering, system science, and information technology as both a textbook. Researchers and practitioners in industry and R&D laboratories working in such fields as system design, control, pattern recognition, data mining, vision, and machine intelligence will also benefit.

A Genetic Algorithm (GA) is a search heuristic that mimics the process of natural selection and is used to generate useful solutions optimization and search problems. It is a subclass of Evolutionary Algorithms (EA), which generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover. Using simple GAs sometimes puts the simulation suffering from getting trapped in local minima and sometimes results in premature convergence. A solution to this is the use of hybrid versions of GA. Chapter 10 provides the hybridization process through the set of benchmark functions both of unconstrained and constrained optimization problems. It also discusses some probable networking optimization application.

Knowledge discovery from data is very important from the utility point of view of the available data. Formal Concept Analysis (FCA) is a mathematical framework that offers conceptual data analysis and knowledge discovery. Chapter 11 analyzes, demonstrates, and compares a few standard algorithms that extract the formal concepts.

Data structures provide the ability to computers to fetch and store data efficiently at any place in its memory. The data structures record and array are based on computing the addresses of data items with arithmetic operations, while the linked data structures are based on storing addresses of data items within the structure itself. Chapter 12 introduces two new data structures called “r-Train” (or “Train” in short) and “r-Atrain” (or “Atrain” in short), which are very suitable for storing huge volume of data. The natural number r is suitably predefined and fixed by the programmer depending upon the problem under consideration and also upon the organization or industry for which the problem is posed. While train stores homogeneous data, atrain is suitable for the purpose of storing heterogeneous data. The term “Atrain” is an abbreviation for “Advanced train.” The two data structures r-train and r-atrain do not have any conflict, which is evident from their functionalities.

Soft set is one of the latest additions to the list of imprecise models to capture uncertainty in data. It has been a practice to develop hybrid models by combining two or models. This provides models, which are better than the individual ones as they capture the important characteristics of the individual models. Therefore, researchers have tried to find hybrid models of soft sets with earlier models like the fuzzy set, rough set, and intuitionistic fuzzy sets. Chapter 13 provides a detailed account of some such hybrid models and their properties.

In the study of different science and engineering subjects, we often encounter texts or problems that are essentially illustrated by figures or diagrams. To understand (and also solve) a problem, the representative diagrams are not a mere convenience but also an inherent component in a person’s cognitive representation of a scientific text or problem. Therefore, diagrams are as important for blind people as they are for sighted people. However, generating and communicating graphics for blind people, in the context of a subject, is not as straightforward as it is for sighted people. Chapter 14 presents a novel

system for drawing geometric diagrams on the Braille medium in order to make the diagram tactile for blind people. The algorithms for drawing digital shapes have been suitably modified to make them work for the Braille environment. The goodness of the diagrams is measured by computing errors in these diagrams. This chapter further demonstrates how the system is helpful for embedding computational intelligence in developing a teaching or learning aid for the blind, especially for teaching them figure-based subjects like geometry, physics, engineering drawing, etc.

List or array is one of the most important data structures in computer science. In fact, functional programming completely depends upon theory of lists. From the mathematical point of view, a list is a generalization of the notion of bags or multisets, which in turn is a generalization of the fundamental notion of sets. Extending the idea of characteristic function of a set and that of the count function of a bag, the notion of position function of a list was introduced by Tripathy et al. in 2001. Relational models are the best-known form of models to represent and manipulate databases and the theory is very rich. An approach to develop relational models using lists was also proposed by Tripathy et al. in 2012 and many related operations like selection and projection have been introduced and studied. Chapter 15 presents all these with informational examples to illustrate the concepts developed. A similar study for the bag theoretic relational algebra for Petri net models was in existence. This has been extended to a more efficient theory of list theoretic relational algebra and Petri net operations have been elaborated in this chapter.

In chapter 13 of this volume, the imprecise model of soft sets has been considered. The content of chapter 16 is in a sense complementary to the contents of that chapter. Besides the preliminary notions about soft sets and some operations on them, a particular type of generalization of soft sets, called generalized fuzzy soft set has been discussed. Many concepts in soft set theory like the soft mapping, soft group, soft ring, soft topology, and soft entropy have been discussed. Most importantly, this chapter discusses some applications of soft sets.

Several attempts have been made for the development of a good dynamic model of pH neutralization process. The nonlinear characteristics and complexity of a pH neutralization plant creates major problems in this process. Among the four types of the pH process, the strong acid-strong base pH process is the most nonlinear. pH control is an interesting and challenging research subject which has led to a large number of motivating and interesting published papers. Out of the various control strategies used for pH control, chapter 17 emphasizes simulation-based pH control. This chapter discusses an adequate dynamic nonlinear pH neutralization model, based on physical and chemical principles that can represent the real pH neutralization plant. This model also facilitates the design, development, and implementation of advanced form of controllers. The research work in this direction mainly concerns about the use of a combined feedback/feed forward system and a highly robust feedback system as an overall control structure and the implementation and testing of the designed controller using latest computer tools. All these have been presented in this chapter.

Equality for the information-knowledge duality is widely known as the fundamental equation of information science. A Shannon-like solution for the fundamental equation of information science is desirable, and in this connection, Brookes's contributions to information science are indisputable. Based on Brookes's premises, information (an outside stimulus) is considered as an element that provokes changes in the cognitive structure (framework) of an individual. In chapter 18, a possible quantitative treatment for information, in accordance with a suggestion by Bawden, combining physical and cognitive aspects, is presented. Further, the treatment in this chapter shows that there is a relationship between Brookes's qualitative equation and Shannon's quantitative equation, and that this relationship can indicate the similarity of both viewpoints.

We strove to keep the book reader-friendly. By a problem solving approach, researchers learn the material through real life examples that provide the motivation behind the concepts and their relation to real world problems. At the same time, readers must discover a solution for the non-trivial aspect of the solution. We trust and hope that the book will help the readers to further carry out their research in different directions.

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Section 1

Classification and Clustering

