

Preface

Industrial engineering is a branch of engineering dealing with the optimization of complex processes or systems. It is concerned with the development, improvement, implementation and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, materials, analysis and synthesis, as well as the mathematical, physical and social sciences together with the principles and methods of engineering design to specify, predict, and evaluate the results to be obtained from such systems or processes. As the complexity of the production and service systems increase, the classical solution techniques to the problems arising from these systems become insufficient.

In the literature, computational intelligence is defined as a methodology involving computing that exhibits an ability to learn and/or deal with new situations such that the system is perceived to possess one or more attributes of reason, such as generalisation, discovery, association, and abstraction. The output of a computationally intelligent system often includes predictions and/or decisions. Or it is defined as follows: Computational intelligence is the study of the design of intelligent agents. An intelligent agent is a system that acts intelligently. It is flexible to changing environments and changing goals, it learns from experience, and it makes appropriate choices given perceptual limitations and finite computation.

Many computational intelligent systems have been developed and appeared in the literature for about 40 years. These have been accepted excellent tools for the solution of the complex problems of industrial engineering, which the classical techniques are not sufficient to solve them. This book aims at presenting the recent developments in computational intelligent systems with industrial engineering applications. The book is composed of 30 chapters, each is summarized below. First chapter briefly summarizes the computational intelligence systems and their application areas in industrial engineering. The second chapter presents a comparison of some a priori and a posteriori decision making support methods,

aimed at aiding the decision maker in the selection of the preferred solutions. The considered methods are compared with respect to their application to a case study concerning the optimization of the test intervals of the components of a safety system of a nuclear power plant. The engine for the multiobjective optimization search is based on genetic algorithms. The third chapter proposes a hybrid fuzzy linguistic recommender system to help the Technology Transfer Office staff in the dissemination of research resources interesting for the users. The system recommends users both specialized and complementary research resources and additionally, it discovers potential collaboration possibilities in order to form multidisciplinary working groups. The fourth chapter presents an extension of its authors' interactive approach to the generation of linguistic summaries through the use of our fuzzy querying interface supporting queries with fuzzy linguistic quantifiers. They concentrate on a specific type of linguistic summaries which parallel specific fuzzy association rules, and show the use of an efficient algorithm for mining such rules. They show an extension to the dynamic case of by using linguistic summaries of times series data. The fifth chapter demonstrates the robustness and uniqueness of fuzzy logic based method with two case studies. The first case study relates to the assessment of the status of ambient air quality in Pune city at the defined locations, while fuzzy description of river water quality in Indrayani River, near Pune for bathing is presented in the second study. The comparison of the results of air/water quality index and the proposed fuzzy logic based method, is an integral part of the paper.

The sixth chapter illustrates the use of TOPSIS method to combine individual safety performance indicators into an overall index of road safety performance for a set of European countries. In this respect, to deal with the subjective kind of uncertainty on data (such as linguistic variables given by experts) which are usually adopted to assess the weights of criteria/indicators, the authors explore an extension of the classical TOPSIS method to fuzzy environments. The seventh chapter proposes and discusses a failure possibility-based reliability algorithm to assess nuclear event reliability data from failure possibilities, which are expressed in qualitative natural languages, mathematically represented by membership functions of fuzzy numbers, and subjectively justified by a group of experts based on their working experience and expertise. The eighth chapter describes the Analytical Network Process, a multi-criteria prioritization method to support decision making in complex and uncertain environments and suggests a fuzzy analytic network process approach for prioritizing decision elements. The proposed fuzzy set theoretic method accommodates fuzziness in the supermatrix computations and thereby provides the opportunity to capture the uncer-

tainty associated with the cumulative influence of each factor on every other factor with which it interacts. The ninth chapter is devoted to swarm intelligence and its engineering applications in nuclear power plants. Particle Swarm Optimization will be used to illustrate the power of such an implementation. The tenth chapter introduces how genetic algorithms are applied to solve the supply chain network design problem. A classification of the recent research in the field provides a valuable insight into current state of literature and outlines directions for future research.

The eleventh chapter proposes and tests the validity and effectiveness of a fuzzy multi-criteria method, called F-Promethee, to help the analyst to compare a set of energy crops and to obtain a ranking of their environmental sustainability. In the twelfth chapter, the previous researches on energy demand forecast are classified and fuzzy techniques are introduced. A fuzzy seasonal time series model that forecasts the energy demand is proposed and illustrated with a real world application. The thirteenth chapter studies a bi-objective re-entrant permutation flowshop scheduling problem in which the jobs have strict due dates. If the manufacturer will not be able to respect any job's due date, that job shall be rejected whether by ignoring it completely or sub-contracting the job. A genetic algorithm coupled with a new dominance concept, different from Pareto, is developed to find a good estimation of non-dominated solutions set. The next chapter provides a general introduction to the structure, algorithm and quality of Self Organizing Maps and presents industrial engineering related applications reported in the literature. The fifteenth chapter presents development and application of a fuzzy mixed integer goal programming (FMIGP) model for rural cooking and heating end-uses. The developed model considers various scenarios such as economical, environmental, social acceptance and local resources to trade off between socio-economical and environmental issues. Due to uncertainty involved in real world energy planning, exact input data is impossible to acquire. Hence, FMIGP model is used to consider four fuzzy objectives. The sixteenth describes chance constrained programming (CCP) to deal with optimization problems in fuzzy environment. CCP models may be solved either by transforming them to their crisp equivalents or by means of fuzzy simulation. This chapter addresses fuzzy simulation which is used for estimating the possibility (credibility) of the constraints, and genetic algorithm (GA) which is applied as an optimization heuristic. The next chapter proposes a computationally effective approach of combining bacterial foraging strategy with particle swarm optimization for solving the minimum makespan problem of job shop scheduling.

The eighteenth chapter uses fuzzy cognitive maps as a modeling tool for traveler satisfaction in public transit systems. The next chapter focuses on optimizing the way of allocating inbound and outbound containers in storage locations, known as the Container Storage Problem (CSP). It proposes a genetic algorithm to solve the CSP for a single and various container types (refrigerated, open side, empty, dry, open top and tank). The main objective of this approach is to find an optimal container arrangement which minimize the re-handle operations of containers at their departure dates (unloading time). The twentieth chapter proposes several fuzzy formulations for fuzzy geometric programming (FGP) by analogy to fuzzy linear programming. Then, the basic GP applications in industrial engineering (IE) are reviewed, and the proposed FGP formulations are adapted to two basic applications of FGP in IE, i.e. to inventory problems and entropy based transportation problems. In the last part of the chapter, a solution approach is proposed for fuzzy inventory problem formulated as a GP model. The twenty first chapter presents a prototype of an automated classification system for thermoplastics that can be integrated on an industrial recycling plant. The main contribution of this new prototype is the use of a novel artificial intelligent classification system based on a multi-sensor strategy. The twenty second chapter provides a mathematical programming basis for distribution network design problem under imprecise data environment. After providing background information about Distribution Network Design (DND) problem as well as fuzzy linear programming, fuzzy linear programming model of DND problem is solved for different α -cut values. The next chapter proposes a new training algorithm to train Convolutional Neural Networks (CNNs) in Optical Character Recognition (OCR) applications. This algorithm is characterized by the use of Gravitational Search Algorithms (GSAs) in combination with the back-propagation algorithm (BP), and a new family of CNNs is suggested. The twenty fourth chapter summarizes the fuzzy techniques, especially the fuzzy clustering and fuzzy programming employed for the cellular manufacturing system design, and their past applications, and offer directions for future research. The twenty fifth chapter tries to provide evidence that joining Self Organizing Maps together with some graphs theory tools (namely: the Minimum Spanning Tree), they can be successfully employed to develop macroeconomic models thus taking both static and dynamic (i.e. over a moving period of time) snapshots of countries financial situations. The twenty sixth chapter aims to present the results of developing a novel swarm optimization method that responds to the need of using multidimensional parameters. This meta-heuristic optimization approach is inspired by the ecological system of animals and their hierarchical relationship. The next chapter presents a hybrid optimization method that

aims at maximizing the Net Present Value related to the investment made by Wind Turbines developers in an active distribution network and smart grids. The proposed method combines a Genetic Algorithm with a multi-period optimal power flow. The twenty eighth chapter investigates the multi-faceted re-mining of association mining results, develops and presents a practical methodology, and shows the applicability of the developed methodology through real world data. The next chapter investigates the performance of several Multi-Objective Evolutionary Algorithms (MOEAs) in discovering solutions to the Competitive Facility Location (CFL) problem and a sensitivity analysis of the solutions related to input parameters. The last chapter focuses on the offset of the interdependencies between aspects of Human Resource Management and the phenomena of fatigue; specifically, the implementation of Bayesian Networks (BNs) with the use of evidence(s) leads in a systematic manner to the projection and evaluation of fatigue.

I hope that this book will provide a useful resource of ideas, techniques, and methods for the research on the applications of computational intelligent systems in industrial engineering problems. I am very thankful to my colleagues Dr. Seyda Serdarasan, Dr. Başar Öztayşi, and Dr. Umut Asan for their selfless and careful work in editing the manuscript of this book. I am also grateful to the referees whose valuable and highly appreciated works contributed to select the high quality of chapters published in this book.

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<http://www.springer.com/978-94-91216-76-3>

Computational Intelligence Systems in Industrial
Engineering

With Recent Theory and Applications

Kahraman, C. (Ed.)

2012, XX, 684 p., Hardcover

ISBN: 978-94-91216-76-3

A product of Atlantis Press