Preface

> As it was stated in the Nine Chapters on the Mathematical Art (Jiu Zhang SuanShu) "Mathematics problems are able to vary to be extremely infinite, fine or unmeasurable. In spite of the much complexity, the approaches can always be discovered, not as difficultly as supposed, which involve no more than measurement, reasoning and calculation to learn common laws".
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> —Hui Liu, The Nine Chapters on the Mathematical Art, no later than 100 BC

The field of optimization is vast with applications appearing in almost every area of science and engineering. Generally speaking, optimization is to do with minimizing or maximizing an objective function (e.g. cost, energy, profit) subject to various types of constraints that arise due to engineering requirements or physical specifications. The optimization techniques for solving optimization problems are particularly important in the aspects of engineering and science applications. There are many efficient optimization techniques available in the literature, while many new techniques continue to be developed so as to meet the needs of solving various new practical problems in areas such as industrial engineering and construction, which are motivated by the need of satisfying more stringent requirements on energy saving, environment protection, and green manufacturing and construction. The natural formulations of the corresponding optimization problems have become much more complicated. The purpose of this edited book is to gather papers which address interesting optimization and control methods and new applications of optimization methods in industrial engineering and construction. Topics include optimization and control theory, statistical measurement, monitoring, fault detection, process control, construction design and production management. This edited book could be used as a reference book for researchers and postgraduate students in science and engineering.

The book is composed of three parts. The first three chapters are devoted to the development of new optimization methods. From "Optimum Confidence Interval Analysis in Two-factor Mixed Model with a Concomitant Variable for Gauge Study" to "Economic Scheduling of CCHP Systems Considering the Tradable Green Certificates", the focus is on the new applications of optimization and control methods in industrial engineering. For the rest of the chapters, different optimization problems in construction projects are being addressed.

In "Robustness of Convergence Proofs in Numerical Methods in Unconstrained Optimization", the robustness of convergence proofs in numerical methods of unconstrained optimization is presented. It is developed based on an important principle in dynamic control system theory, where control policies are preferred to be of feedback form, rather than in an open loop manner. In "Robust Optimal Control of Continuous Linear Quadratic System Subject to Disturbances", the robust optimal control of linear quadratic system is considered. It is formulated as a minimax optimal control problem which admits a unique solution. A control parameterization scheme is developed to transform the infinite dimensional optimal control problem to one with finite dimension. It is further shown that the transformed finite-dimensional optimal control problem can be solved through semi-definite programming. In "A Linearly-Growing Conversion from the Set Splitting Problem to the Directed Hamiltonian Cycle Problem", a linearly growing conversion from the set splitting problem to the directed Hamiltonian cycle problem is discussed. A constructive procedure for such a conversion is given, and it is shown that the input size of the converted instance is a linear function of the input size of the original instance.

In "Optimum Confidence Interval Analysis in Optimum Confidence Interval Analysis in Two-Factor Mixed Model with a Concomitant Variable for Gauge Study", the efforts on optimum confidence interval analysis in two-factor mixed model for gauge study are studied. The analysis of variance is performed in the model and variabilities in the model are represented as a linear combination of variance components. Optimum confidence intervals are constructed using a modified large sample approach and a generalized inference approach is proposed to determine the variability such as repeatability, reproducibility, parts, gauge and the ratio of variability of parts to the variability of gauge. In "Optimization of Engineering Survey Monitoring Networks", the focus is on various ways of engineering survey monitoring networks, such that those used for tracking volcanic and large-scale ground movements may be optimized to improve the precision. These include the traditional method of fixing control points, the Lagrange method, free net adjustment, the g-inverse method and the singular value decomposition (SVD) approach using the pseudo-inverse. In "Distributed Fault Detection Using Consensus of Markov Chains", a fault detection procedure appropriate for use in a variety of industrial engineering contexts is proposed, where consensus among a group of agents about the state of a system is employed. Markov chains are used to model subsystem behaviours, and consensus is reached by way of an iterative method based on estimates of a mixture of the transition matrices of these chains. In "Engineering Optimization Approaches of Nonferrous Metallurgical Processes", an intelligent sequential operating method based on genetic programming is developed for solving nonferrous metallurgical processes, where optimization is being carried out while avoiding violent variation by operating the parameters in the ordered sequence. Real practical industrial data are used for carrying out the verification. In "Development of Neural Network Based Traffic Flow Predictors Using Pre-processed Data", a simple but effective training method by incorporating the mechanisms of back-propagation algorithm and the

exponential smoothing method is proposed to pre-process traffic flow data before training purposes. The pre-processing approach intends to aid the back-propagation algorithm to develop more accurate neural networks, as the pre-processed traffic flow data are more smooth and continuous than the original unprocessed traffic flow data. This approach is evaluated based on some sets of traffic flow data captured on a section of the freeway in Western Australia. Experimental results indicate that the neural networks developed based on this pre-processed data outperform those that are developed based on either original data or data which are pre-processed by the other pre-processing approaches. In "Economic Scheduling of CCHP Systems Considering the Tradable Green Certificates", tradable green certificate mechanism is introduced for the operation of CCHP system, and the impacts of tradable green certificate on the scheduling of CCHP system are studied. Then the economic dispatch model for multi-energy complementary system considering the TGC is proposed to maximize renewable energy utilization. This is a non-convex scheduling optimization problem. A global descent method is applied, which can continuously update the local optimal solutions by global descent functions. Finally, one modified IEEE 14-bus system is used to verify the performance of the proposed model and the optimization solver.

The remainder of the book relates to construction engineering optimization, more or less. Many types of optimization problems arise in construction engineering, such as sizing optimization, shape optimization, topology optimization, production optimization, contract dispatching and project management. Considering the differences in production conditions in the manufacturing industry, these problems are worth studying and complex for seeking valuable laws in optimization. First, the construction is rooted in place and conducted as on-site manufacturing. Second, every construction project is unique and a one-of-a-kind production, managed by a temporary organization, and consists of several companies. Third, highly interdependent activities have to be conducted in limited space, with multiple components, a lack of standardization and with many trades and subcontractors represented on-site. In "Optimizations in Project Scheduling: A State-of-Art Survey", a state-of-art survey of project management and scheduling is presented. This survey focuses on the new optimization formulations and new solution algorithms developed in the recent years. In "Lean and Agile Construction Project Management: As a Way of Reducing Environmental Footprint of the Construction Industry", a way of reducing the environmental footprint of the construction industry is proposed with the concept of lean and agile construction project management. It focuses on the construction project management with respect to the agility and leanness perspective and provides an in-depth analysis of the whole project life cycle phases based on lean and agile principles. Considering managing construction projects in Hong Kong, dynamic implications of industrial improvement strategies are analysed in "Managing Construction Projects in Hong Kong: Analysis of Dynamic Implications of Industrial Improvement Strategies". Based on a series of face-to-face interviews with experienced practitioners and a focus group exercise, this chapter presents the mapping of various interacting and fluctuating behaviours patterns during the site

installation stage of building services in construction projects, with the aid of a generic system dynamics model, and draws interesting conclusions about the relationships among factors in construction project management. In "Dynamic Project Management: An Application of System Dynamics in Construction Engineering and Management", system dynamics (SD) are taken into consideration for construction engineering and project management. It is expected to serve as a useful guideline for the application of SD in construction and to contribute to expanding the current body of knowledge in construction simulation. Since production control is an essential part of any complex and constrained construction project, a lean framework for production control in complex and constrained construction projects (PC^4P) is discussed in "A Lean Framework for Production Control in Complex and Constrained Construction Projects (PC^4P)", which is based on an open system-theory mindset and consists of components, connections and inputs. In "Optimization in the Development of Target Contracts", by formulating the sharing problem in optimization terms, specific quantitative results will be obtained for all the various combinations of the main variables that exist in the contractual arrangements and project delivery. Such variables include the risk attitudes of the parties (risk-neutral, risk-averse), single or multiple outcomes (cost, duration, quality), single or multiple agents (contractors, consultants), and cooperative or non-cooperative behaviour. This chapter will be particularly of interest to academics and practitioners in the discipline of the design of target contracts and project delivery. It provides an understanding of optimal sharing arrangements within projects, broader than currently available.

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