Preface


SECTION 1: OPTIMIZATION METHODOLOGIES

Section one consists of 6 chapters. In Chapter 1, Payam Hanafizadeh, Abolfazl Ghaemi, and Madjid Tavana conduct a “Local Perturbation Analysis of Linear Programming with Functional Relation among Parameters.” The main purpose of classical sensitivity analysis is to examine the variations of the objective function’s optimal values and the solution components as a result of the infinitesimal changes in one of the parameters while the other ones are kept fixed. One of the problems confronted in classical sensitivity analysis is when several parameters are changed simultaneously. In those cases, classical methods cannot obtain the effect of the perturbations on the objective function as well as on the optimal solution because when the simultaneous changes happen in the amplitudes range of basic variables or binding constraints, the order of basic solution changes. Although the importance of sensitivity analysis in linear programming has been widely stressed in the management science literature, the research on sensitivity analysis with functional relation has been sporadic and scattered. Usually variation occurs in the right-hand-side of the constraints and/or the objective function coefficients. In this chapter, the authors consider the sensitivity analysis for a class of linear programming problems with functional relation among the objective function parameters or those of the right-hand-side. The classical methods and standard sensitivity analysis software packages fail to function when a functional relation among the linear programming parameters prevails. In order to overcome this deficiency, they derive a series of sensitivity analysis formulae and devise corresponding algorithms for different group of homogenous linear programming parameters. The validity of the derived formulae and devised algorithms is corroborated by open literature examples having linear as well as nonlinear functional relations.

In Chapter 2, Heping Liu and Yanli Chen explore “Taylor Kriging Metamodeling for Stochastic Simulation Interpolation.” Interpolation is a key problem of simulation modelling. The objective of interpolation is to significantly reduce the times and thus the expense of running a simulation model. In this chapter, the authors applied a novel Kriging model to the interpolation of stochastic simulation with high computational expense. The novel Kriging model is called Taylor Kriging, and it was developed by integrating Taylor expansion with Kriging and using Taylor expansion to construct the drift function of Kriging. To investigate the interpolation accuracy of Taylor Kriging in stochastic simulation, the authors
performed the empirical analysis and comparison based on two stochastic simulation cases. The two simulation cases were formulated according to two multimodal benchmark functions. Latin Hypercube Sampling was used to generate initial simulation inputs since it is computationally less expensive and can avoid redundant sampling and ensure that there are sufficient observations. By comparing the interpolation results of Taylor Kriging with those from two typical classes of Kriging models, that is, Simple Kriging and Ordinary Kriging, the authors conclude that the interpolation of Taylor Kriging is more accurate and has the advantage of accuracy. In the Kriging interpolation for stochastic simulation, there are two crucial parameters, namely the number of simulation replications and the variance of random variable, which influence the interpolation accuracy of Kriging and need to be investigated. While investigating these two parameters, the authors tried to answer such two questions: how many simulation replications are needed so that Kriging can provide valid mean outputs by interpolation, and how does the variance of a random variable influence the interpolation performance of Kriging?

In the simulation with costly computational expense, the selection of simulation replications becomes important. It is necessary to limit the number of replications in order to reduce the computational expense while obtaining valid Kriging interpolation outputs. According to the empirical analysis, the authors indicated that in stochastic simulations, 50 simulation replications may be a good threshold, and running more than 50 replications can improve the accuracy of Kriging in interpolating simulation output means. Although this threshold is obtained based on only two stochastic simulation cases, and more theoretical and empirical work is needed, it provides a rough guidance in selecting the number of replications. In the empirical investigation, the authors noted that the variance of random variable in stochastic simulation can influence the interpolation performance for output means. Their empirical results further disclosed that a larger variance makes interpolation less accurate.

In Chapter 3, Ali Ebrahimnejad, Seyed Hadi Nasseri, and Sayyed Mehdi Mansourzadeh introduce “Bounded Primal Simplex Algorithm for Bounded Linear Programming with Fuzzy Cost Coefficients.” The aim of linear programming problems in the crisp environment is maximizing or minimizing a linear objective function under linear constraints. But in many practical functions situations, the decision maker may not be able to specify the objective and/or constraint precisely but rather can specify them in a fuzzy sense. In these situations, it is desirable to apply some fuzzy linear programming (FLP) type of modelling so as to provide more flexibility to the decision maker. Therefore, a number of researchers have shown interest in the area of FLP problems. In general, FLP problems are first converted into equivalent crisp linear or nonlinear programs, which are then solved by standard methods. In effect, most convenient methods are based on the concept of comparison of fuzzy numbers by use of ranking functions which is desired in this study. Since the fuzziness may appear in a linear programming problem in many ways, the definition of FLP problem is not unique. Instead of discussing the general type, the authors focus on a special case of FLP known as reduced fuzzy numbers linear programming (RFNLP) problem in which the cost coefficients are represented by fuzzy numbers and remaining parameters are crisp.

There are two important approaches based on linear ranking functions for solving RFNLP problems. The first approach generalized the primal simplex method for solving RFNLP problems. This fuzzy algorithm, starting a basic feasible solution moves to another basic solution with a better (at least not worse) objective value until it finds an optimal basic feasible solution after a finite number of steps. The second approach, namely fuzzy dual simplex method, starts with a dual basic feasible solution, but primal basic infeasible solution and walks to an optimal solution by moving among adjacent dual basic feasible solutions. However, these methods for solving the RFNLP problem have a shortcoming and it is not efficient when some or all variables are restricted to lie within lower and upper bounds. In this study,
as a natural extension of the results in crisp linear programming and based on a certain linear ranking function the authors extend the primal simplex method to overcome this shortcoming. However, the authors realize that the results obtained here are independent of the choice of the linear ranking function. In fact, the authors can use any other linear ranking function, and although the solution obtained may be different but the results are still valid for the new solution.

Chapter 4, entitled “Sensitivity Analysis on Linear Programming Problems with Trapezoidal Fuzzy Variables,” is written by Seyed Hadi Nasseri and Ali Ebrahimnejad. Fuzzy set theory has been used in many fields such as control theory, mathematical modeling, operations research, and many industrial applications. In the real word, there are many problems which have linear programming models and sometimes it is necessary to formulate these models with parameters of uncertainty. Many numbers from these problems are linear programming problems with fuzzy variables. Some authors considered these problems and have developed various methods for solving these problems. Recently, Mahdavi-Amiri and Nasseri considered linear programming problems with trapezoidal fuzzy data and/or variables and stated a fuzzy simplex algorithm to solve these problems. Moreover, they developed the duality results in fuzzy environment and presented a dual simplex algorithm for solving linear programming problems with trapezoidal fuzzy variables. In this chapter, the authors show that this presented dual simplex algorithm directly using the primal simplex tableau algorithm tends the capability for sensitivity (or post optimality) analysis using primal simplex tableaus.

Mohammed Hajeeh investigates “Optimizing Series Repairable Systems with Imperfect Repair” in Chapter 5. Components within operating systems function faultlessly when they are new; however, over time their performance is weakened and the frequency of failure increases because of events such as fatigue, break, leakage, and wear. Upon failure, they are either replaced by a new one, or are repaired. Repair is either perfect, bringing the component to the status of, as good as new, minimal repair, bringing the component to its state just before failure, or imperfect repair where the component’s function becomes inferior after each repair. Perfect repair is usually carried out on non-expensive or critical components, whereas minimal and imperfect repair is used for expensive and non-critical components. The author in this study has examined the performance and cost of a system undergoing imperfect repair, where the failed component is repaired several times before complete replacement. In such repair action, the failure rate increases and the repair rate decreases after each repair. It is assumed in this study that each failure rate and repair rate is a function of the preceding failure rate and repair rate, respectively. Other assumptions include: exponentially distributed times between failures and repair rates, failure rates and repair rates are constant for all components, all failures are statistically independent, the travel times to and from the repair facility are negligible, and the system becomes as good as new after each replacement.

Two versions of a one-component repairable system with imperfect repair are considered with the objective of finding the optimal failure and repair rates at a minimum cost for a specified availability level. In the first version, the component upon failure is imperfectly repaired, and is consequently replaced after several repairs, while in the second version after each failure; it is either repaired with probability p or is replaced with probability 1-p. The methodology utilized in this study involved the construction of two mathematical models for each version; both models consist of a nonlinear objective function and several constraints. The objective function is composed of three costs namely the purchase cost, repair cost, and down time cost. The down time cost is the cost of opportunity lost when the system is in the failed state. The constrained optimization models are relaxed by transforming them into non-constrained models using Lagrange multipliers. The Lagrangian models are solved using Kuhn Tucker conditions.
In both models, the optimal failure and repair rates and cost were found to be best expressed in terms of the purchase cost, the repair cost, and the level of availability desired.

In Chapter 6, Adel Hatami-Marbini, Saber Saati, and Madjid Tavana perform “Data Envelopment Analysis with Fuzzy Parameters: An Interactive Approach.” Data Envelopment Analysis (DEA) is a widely used mathematical programming technique for evaluating the relative efficiency of Decision Making Units (DMUs) in organizations. Crisp input and output data are fundamentally indispensable in traditional DEA evaluation process. However, the input and output data in real-world problems are often imprecise or ambiguous. Some researchers have proposed various fuzzy methods for dealing with the imprecise and ambiguous data in DEA. However, the authors argue that these methods do not consider the preferences of the decision makers in the evaluation process. They propose an interactive evaluation process for measuring the relative efficiencies of a set of DMUs in fuzzy environment with consideration of the decision makers’ preferences. They construct a linear programming model with fuzzy parameters and calculate the fuzzy efficiency of the DMUs for different α levels. They then identify the decision maker’s most preferred fuzzy goal for each DMU under consideration. They introduce a modified Yager index to develop a ranking order of the DMUs.

The main thrust of their study is to allow the decision maker to use his or her preferences or value judgments when evaluating the performance of the DMUs. In the DEA framework proposed in their study, the decision maker defines uncertain data by means of language statements and determines a preferred fuzzy goal based on the obtained fuzzy efficiencies of the DMUs for different levels. In other words, the decision maker can interactively impact the ranking of the DMUs with his/her most preferred goal. Although all the efficiencies of the DMUs obtained from the fuzzy DEA model are mathematically acceptable, they show that a decision maker can utilize his/her preferences in relation to the conflicting objectives and select his/her most preferred DMU. Finally, they aggregate the fuzzy efficiency values and the fuzzy goals stated by the decision maker for each DMU and use this measure to rank the DMUs on the basis of their efficiencies. They conclude that their proposed framework is interactive, generic, structured, and comprehensive and can be applied to analyze various DMU evaluation problems in fuzzy environments.

SECTION 2: BUSINESS ANALYTICS

Section two consists of 6 chapters. Ibrahim Almojel, Jim Matheson, and Pelin Canbolat focus on “Information in Fleeting Opportunities” in Chapter 7. This work considers situations in which a decision maker has a flow of fleeting deals arriving over time, which must be studied, and accepted or rejected before another deal can be considered, a situation with Fleeting Opportunities. This setup is an abstraction for many decision processes, including those used by venture capital firms evaluating business pitches and movie producers evaluating script proposals. The authors address an important extension to the well-studied research on optimal stopping problems and present interesting general results. The main challenge in the situations studied is evaluating the alternatives for the current deal at hand given unknown deals that lie in the future. Two types of preliminary activity may be undertaken before making the accept or reject decision, which are to gather information about the deal at hand, potentially clarifying the uncertainties about the deal, or taking actions to influence the uncertainties inherent in the deal, in the hope of improving the deal. This work models these activities as information gathering and control, in the decision analytic sense, and evaluates them within the context of the deal flow.
The authors formulate the generic problem as a dynamic program where the decision maker can either accept a given deal directly, reject it directly, or seek further information on its potential and then decide whether to accept it or not (the control situation can be treated similarly). The decision must be made before the next deal arrives within a finite time-horizon. The total value to the decision maker is modelled as an additive function of the accepted deals, and the preferences of the decision maker are characterized by a linear or an exponential utility function. The authors study the incremental deal value, defined as its value given the location within the process, the value of information and control, and the optimal policy across time and capacity dimensions. In many practical instances of this problem, the decision maker faces a large number of periods. The solution to the infinite-horizon problem, under certain conditions, admits a stationary optimal policy that is an extension of the finite-horizon problem. The authors’ results show surprisingly well-behaved characteristics of the optimal policy, deal flow value, and the value of information over time and capacity.

In Chapter 8, Yefim H. Michlin, Dov Ingman, and Yoram Dayan finish a “Sequential Test for Arbitrary Ratio of Mean Times between Failures.” This chapter deals with development of a planning methodology and tools for truncated comparison SPRT (sequential probability ratio test) evaluation of two items. This SPRT is intended to check that the ratio of the mean times between events involving the items is not less than a specified value. Examples of such events are failures of the items in reliability situations, or implementation of a service rendered to a customer by a server. Such a comparison is affected, for example, in compliance (acceptance) testing. In the proposed test the compared items are tested simultaneously, which permits exclusion of variable ambient and loading conditions. In the field of reliability the goal of such a test can be, for example, to verify that: 1) A new item is superior in reliability to a predecessor, which is of special importance in accelerated tests; 2) A new production/repair technology for an item enhances/does not impair its reliability. In the field of service centers, the goal can be, for example, to verify that the mean solution time of a customer’s problem by a new group of servers is less by a specified factor than for the reference group. It is shown in the chapter that under exponential distribution of the time between events the proposed test reduces to a special form of a binomial SPRT. The latter have been known for many years and extensive literature is available on them. Still, improvement is desirable regarding the practical aspects of their planning, especially for the truncated type.

The contribution of this chapter to the theory and practice of sequential tests covers the following areas: 1) A new comparison SPRT type, and a methodology for its planning; 2) Quality criteria permitting unambiguous identification of the optimal test, and forming the basis for its algorithm of planning by computer. These criteria accommodate a wide range of test types, and permit their comparative assessment; 3) Formulae for the expected values and limits between which the boundary parameters of the optimal test can be searched for, rapidly and reliably. These expected values yield the sought parameters for a wide range of the tests in question, without any additional searching.

The methodology is also applicable in group tests, with the attendant time economy; moreover, it permits optimization of the respective group sizes. A detailed planning- and implementation example is presented for the case where each item is represented by an optimal-sized group of products. This permitted substantial economy in the calendar duration of the test, thereby rendering it acceptable for the user.

In Chapter 9, Satadal Ghosh and Sujit Kumar present “Portfolio Selection Models and their Discrimination.” The area of Portfolio Management received constant attention of leading economists, statisticians, and mathematicians around the world because of the difficulty in finding an appropriate portfolio selection model in the face of highly stochastic behaviour of financial markets. Starting with the very basic Markowitz’s model, scores of increasingly complex portfolio selection models have been
developed both in Non-Bayesian and Bayesian framework to address vagueness, ambiguity and subjective opinions and also, imprecision and subjectivity in data. Abundance of models has made it quite difficult for a learned investor to select a model that would give him the best portfolio with real life data on price movements of stocks. The authors made commendable attempts to make the job simpler for an investor by developing a novel framework for model discrimination using Data Envelopment Analysis (DEA) in which Maverick index was used as a measure of portfolio diversification, where, the less the Maverick index the better the diversification is. The concept of Signal to Noise (S-N) Ratio was also gainfully used for model discrimination purpose for the first time in this context in literature, where higher S-N ratio implies higher average appraisal and lower variability, hence indicating more robustness and stability under different financial market scenarios.

The study availed historical data on closing prices of a select stock set consisting of ten highly traded and valued stocks, encompassing all major industry sectors in India, over a period of one full year from National Stock Exchange (NSE) of India. The authors considered major Non-Bayesian portfolio selection models (Markowitz model with historical average and ARMA-GARCH time series forecasted stock returns, Fuzzy probability model, Lower and Upper fuzzy possibility distribution model, Optimistic, Pessimistic and their convex linear combination [CLC] Interval coefficient quadratic model, and Regret function based Interval coefficient model) for model discrimination. Nine model-specific different optimum portfolios, which were obtained by solving nonlinear mathematical programming problems formulated for the selected models, were fed as input to the DEA problem formulation while risk premium and unsystematic risk were the output components. These optimum portfolios were discriminated with the help of (1) simple efficiency and cross efficiency matrix obtained from DEA; (2) Maverick behaviour analysis; and (3) S-N Ratio analysis. Interestingly, ranking of the optimum portfolios based on DEA-Maverick index and S-N Ratio were found to be identical. The optimum portfolio given by the Regret Function based Interval Coefficient model and the Fuzzy Probability model were found to be the best and worst portfolio, respectively, in terms of well-diversification with minimum risk premium. The authors also proposed to extend the study in future to accommodate portfolio selection models developed in Bayesian framework.

In Chapter 10, Gary H. Chao, Maxwell K. Hsu, and Carol Scovotti demonstrate “Predicting Donations from a Cohort Group of Donors to Charities: A Direct Marketing Case.” Non-profit organizations implement various fundraising campaigns throughout the years to raise money and support their causes. Their success depends on their ability to accurately predict the revenue flow from these fundraising appeals. Research on fundraising suggests that the factors that stimulate donations are unique to industry category, for example, healthcare or higher education. Personal donor information strongly signals one’s likelihood to donate to a particular charity.

However, what if such information is unavailable? To what extent can non-profits accurately forecast future donation revenue in the absence of industry and individual information? In their chapter, the authors examined this forecasting issue from a transactional perspective. Their dataset, provided by the Direct Marketing Educational Foundation, contained six years of donation history generated by over 21,000 donors to a U.S. non-profit organization. Information was limited to appeal dates and costs, donation dates and amounts by donors, with source attribution for each donation. Using data generated from September 2002 through August 2006, they employed seven different forecasting models to predict donation amounts expected during the September 2006 through August 2008 timeframe. They then compared each model’s results to the actual findings in the dataset.
Findings suggested that when faced with limited data, non-profits might use transactional history to reasonably predict donation amounts. Their study identified several strengths and weaknesses of the seven forecasting methods. For example, models that utilize time series data underestimate total gift amounts. Alternatively, models that focus on behavioural factors such as recency, donation frequency, and monetary value are considerably more accurate. In addition, recency is a better predictor of future donations than the overall average donation amount of the individual. In fact, the recency-monetary model was the most accurate of all of the models tested. Models that segment a dataset into subgroups - in this case, low versus high frequency/low versus high gift amount - provide superior forecasting accuracy than those that treat the dataset as a single homogeneous entity.

While it would be unusual for a non-profit organization to not know its industry classification, the absence of personal data is very possible. This study demonstrates that when armed with basic knowledge of modern forecasting techniques and increasingly user-friendly statistical software packages, marketing managers can establish realistic donation expectations using just transactional data and, as a result, achieve gains that would be a plus to non-profit organizations’ customer relationship management efforts.

Mohammadreza Alirezaee and Mohsen Afsharian point toward “Measuring the Effect of the Rules and Regulations on Global Malmquist Index” in Chapter 11. Data envelopment analysis (DEA) is a mathematical optimization-based method that measures the productive efficiency of similar decision-making units (DMUs) with multiple inputs and outputs without recourse to a priori weights and without requiring explicit specification of functional forms between inputs and outputs. The circle-type or global Malmquist index, which is based on Data Envelopment Analysis (DEA) models, is an important index that is widely used for measuring the relative productivity change of decision-making units (DMUs) in multiple time periods. This index, similar to the standard approach of measuring the productivity change using the standard Malmquist index, breaks down into various components, which can then be used to measure the impact of the efficiency, technology, and scale on productivity changes over time. However, empirical studies show that there are some rules and regulations that can affect the result of the productivity changes. Therefore, this chapter presents new insight into the global Malmquist index for measuring the effect of the rules and regulations on productivity changes that come from imposing some trade-offs to the production possibility set of the problem, and provides a new decomposition of this index.

In Chapter 12, Ue-Pyng Wen, Yun-Chu Chen, and Kam-Hong Cheung prefer the “Equal Pricing Strategies in a Dual Channel Supply Chain.” The Internet has advanced rapidly over the past decade so that many famous manufacturers sell their product directly via the Internet (direct channel) in addition to independent retailers. For a manufacturer, a direct channel not only delivers information about the company and products in a relatively inexpensive way but also allows the manufacturer to reach newer market segments. However, the direct channel may affect the channel relationship and cause conflicts with the existing retail channel (traditional channel). Consequently, the retailer faces demand shift and price competition. The authors consider a simple supply chain composed of one manufacturer and one retailer. The manufacturer is assumed to be a leader who first sets the wholesale price and retail price in the direct channel. The retailer is then assumed to be the follower who accordingly sets the retail price in the traditional channel. This chapter investigates equal pricing strategies in a dual channel supply chain according to the assumption that the manufacturer commits setting the same retail price as the traditional channel to reduce the channel’s conflict. The authors first construct linear demand functions, which represent how the retail price, service quality and effort required by the channel affect the consumer’s choice. Accordingly, this chapter presents which conditions benefit the profits of the retailer and/or the
manufacturer compared with the unique traditional channel. Next, the authors examine the effect of the coordinate game between the two channels and derive the conditions under which the total profits increase as the amount of effort required by the channel decreases. Finally, using numerical results, the authors explore the market behaviour under different parameters. This chapter shows that the manufacturer always benefits by reducing the amount of effort required by the direct channel and the retailer also gains by adjusting the service quality. In addition, the equal price strategy is applicable to the manufacturer as the direct channel is less effort required to buy than the traditional channel. However, if the service quality causes a threat to the direct channel, then the manufacturer should abandon the commitment.

SECTION 3: LOGISTICS OPTIMIZATION

Section three consists of 5 chapters. Chapter 13 entitled “Multi Depot Probabilistic Vehicle Routing Problems with a Time Window: Theory, Solution and Application” is written by Sutapa Samanta and Manoj K. Jha. The authors review the Vehicle Routing Problem (VRP) which has been extensively studied in the last three decades due to its widespread applicability in many real-world logistics and routing operations. Of notable significance are three key extensions to classical VRPs: (1) multi-depot scenario; (2) probabilistic demand; and (3) time-window constraints. Combining all three extensions together leads to a Multi Depot Probabilistic Vehicle Routing Problem with a Time Window (MDPVRPTW), which is a very interesting problem to solve since it is encountered in many pick-ups, delivery, and other kinds of routing/logistics operations, such as highway infrastructure maintenance scheduling and snow-plowing operations. Numerous formulations and solution algorithms have been developed for different variations of the VRPs depending on their level of complexity. Various components of MDPVRPTW pose both formulation challenge as well as algorithmic challenges from solution perspective. The authors have presented a formulation and solution methodology for MDPVRPTW and performed extensive sensitivity analysis.

The authors designed an experimental set up for formulating a real-world MDPVRPTW. Because of their extensive experience with Genetic Algorithm (GA) and its proven capability in efficiently converging to a global optimum, they developed a solution algorithm to the so called MDPVRPTW using a GA. Through an extensive literature review the authors observed that various researchers not too familiar with GAs and other Artificial Intelligence (AI)-based heuristics generally sought sophisticated mathematical procedures to solve different variations of VRPs. Within the GAs, two modification operators namely, crossover and mutation, were designed specially to solve the MDPVRPTW. The GA-based heuristic exhibited robust nature and efficiency in terms of computing time for the MDPVRPTW problem.

The authors performed three numerical examples with 14, 25, and 51 nodes to test the efficiency of the GAs using a route network of varying complexity. In all cases, the GAs were found to perform satisfactorily and the limiting case solutions were in agreement with the constraints. The optimal objective function values resided within the specified limits for all the three instances. While there was no rigorous proof to show the optimality of the solutions, it was at least intuitively evident that the solutions were optimal as they were compared in their limiting cases with classical VRPs by relaxing the time-window and stochasticity constraints. It was also found that on the average, there was about 20% improvement from the initial solution sets for the three instances. Additional tests were needed to be performed to examine the efficiency of the heuristic on larger problems, which were left for future works.
Li Pan, Sydney C. K. Chu, Guangyue Han, and Joshua Zhexue Huang develop “A Heuristic Algorithm for the Inner-City Multi-Drop: Container Loading Problem” in Chapter 14. Economic globalization, increasing fuel cost, and environmental problems have made city logistics become a vital factor in sustainable development of cities. For typical distribution centers, the most frequent city logistics activities are preparation and transportation of products to retail shops in small replenishment lots. In order to facilitate these activities to satisfy population needs with low costs, outbound trucks often deliver goods to multiple client locations during one trip. When using this option, a good truck loading method is critical for successfully reducing supply chain costs. The truck loading method used should consider not only the traditional loading constraints, but also the multi-drop requirement, which requires that items can be unloaded without rearranging other items at their drop-off points. This problem is NP-hard. Despite its importance in practice, little literature is available on the so-called container loading problem with multi-drop constraint.

In this chapter, Pan et al. solved this problem by proposing an efficient and effective wall-building heuristic algorithm to load trucks. The wall-building method is used here because of its easy adaptation to meet the multi-drop constraint and easy implementation in practice. The algorithm is based on the binary tree data structure with the objective to maximize the container space utilization. The container is filled by a number of walls from the back to the entrance across the length of the container. Unlike general wall-building, the wall’s depth here is decided by a flexible dynamic wall space decomposition strategy, and the “data-dependent” problem of the wall-depth is alleviated by adopting several ranking functions regarding different characteristics of items. Furthermore, they apply a space repacking strategy and wasted spaces amalgamation, with items pairing techniques used to further improve the solution. This algorithm can produce a good packing plan that is very efficient for a set of products to be distributed to different destinations in one route. One significant feature of this algorithm is its simplicity and flexibility. It can be easily implemented in the real world setting and flexible enough to accommodate various other operational issues, such as its related vehicle routing problem. For numerical results, Pan et al. demonstrated the validity of their proposed algorithm by experimentally comparing the model’s results with those of some other recent algorithms and evaluated the performance of their algorithm with multi-drop constraint on benchmark data instances.

In Chapter 15, Subhro Mitra, Joseph Szmerekovsky, and Nikita Barabanov display “A Stochastic Truck Routing Model for Agricultural Freight.” In this chapter, the authors analyze the routing of agricultural freight from the fields to the elevators. They formulate a number of optimization models to analyze the effects of truck type restrictions in the truck mix on the overall system cost of delivering from fields to elevators. The models account for both the selection of truck type and load type for deliveries while respecting the load restrictions imposed on the highway network. The estimated origin-destination matrix is assigned on the highway network using a stochastic model. The stochastic model is designed to take into account the different behavior of truck traffic as opposed to passenger vehicle traffic and is implemented using simulation. The models developed here are tested on the highway network of North Dakota. This model results show that there is considerable cost savings by relaxing the truck restriction type in the truck mix. Though there are a number of factors associated with transitioning over from one truck type to the other, in the long run it might be profitable to adapt a particular truck type for a particular origin-destination pair. Despite the clear cost advantages of relaxing the restriction on the truck mix, the model still includes the assumption of continuous variables. Non-integer variables in the solution correspond to less-than-truckload (LTL) deliveries. If these LTL deliveries can be rerouted and freight from adjacent farms collected to be delivered to an elevator there could be considerable cost savings.
This would require agreement between adjacent farms regarding truck usage and also identifying the destination elevator. A topic of future research would be to develop a heuristic model to optimize the LTL deliveries. They would like to make their results available to the NDDOT and other transportation planners, who might discuss these results in public input meetings and give us some feedback on the findings. Their preliminary discussion with people knowledgeable in this area revealed a practical difficulty of rerouting the LTL trucks. The elevators pay the farms based on the weight of crop freight delivered in a truck; if the truck contains crops from a number of farms a practical difficulty would be to determine the weight of crop delivered individual farms. It is their hope that the stochastic truck traffic assignment model which they have developed here will set off research in this area. They have used the survey results available from a previous study to determine the distribution pattern of the cost function. In the future they would like to do research to determine the explanatory variables affecting route choice.

Avijit Maji and Manoj K. Jha concentrate on “Highway Alignment Optimization Using Cost-Benefit Analysis under User Equilibrium” in Chapter 16. The authors’ research team has extensively studied the Highway Alignment Optimization (HAO) problem over the last two decades. In the classical HAO problem, a best 3-dimensional highway route is sought between two end points, subject to user preferences. This problem has been formulated and solved by many researchers over the last 50 years. However, real-world problems are quite challenging since many trade-off opportunities, such as a balance between cost and environmental sensitivity have to be carefully and efficiently investigated. In view of the real-world complexity, the authors formulated the HAO problem as a unique optimization problem in a way that prompted investigation of various Artificial Intelligence (AI)-based heuristics for a possible solution approach.

In the current chapter, the authors depart from the traditional HAO problem in that they investigate a road-users’ preference in seeking a new highway route between his/her Origin-Destination (O-D) pair as opposed to previously available routes between those O-D pairs. Intuitively, the users would choose a route that will minimize their travel-time and they will unilaterally shift to the available routes for their benefit (in terms of travel-time savings), a phenomena popularly known as User Equilibrium (UE). This will, in turn, ensure that the traffic flow along all routes in the network leading to the destination attains equilibrium. To capture this situation in the highway planning and route selection process, the authors developed a new methodology to optimize a three-dimensional highway alignment based on the existing highway alignment system information using a cost-benefit analysis approach. A Genetic Algorithm (GA) was designed for solving the optimization problem.

The authors found the results obtained by considering the cost-benefit analysis using User Equilibrium (UE) principle for highway alignment optimization to be quite optimistic. They further noted that the implementation of new alignment as a bypass for the existing highway would definitely improve the present traffic scenario. The methodology would minimize highway alignment cost while the benefits were maximized simultaneously. It will reduce the vehicle operation, travel time, and accident cost of the existing highway network. The reduction in travel time cost was observed to be the highest. This was because of the congestion relief in the existing highway network as a result of the new bypass. Reduction of other costs in existing highway was also considerable. The results were found to be quite promising for new road design and bypass construction since benefit maximization and cost minimization were performed simultaneously while attaining user equilibrium. The approach can be employed and tested in various real-world road planning and design projects in future works.

Amit Kumar and Amarpreet Kaur highlight the “Methods for Solving Fully Fuzzy Transportation Problems Based on Classical Transportation Methods” in Chapter 17. There are several methods in the
literature for finding the fuzzy optimal solution of fully fuzzy transportation problems (transportation problems in which all the parameters are represented by fuzzy numbers). But the authors of this chapter present two new methods for solving fully fuzzy transportation problems, which cannot be solved by existing methods. The utility of the proposed methods is described with examples. The explanation of methods and their analysis is very interesting.

Authors pointed out that there are shortcomings and limitations in these existing methods which are as follows. Shortcomings include: (1) In the existing methods the final results of fully fuzzy transportation problems are real numbers, which represents a compromise in terms of fuzzy numbers; (2) In the existing methods there exist negative part in all the obtained trapezoidal fuzzy numbers, which depicts that quantity of the product and transportation cost may be negative. But the negative quantity of the product and negative transportation cost has no physical meaning. So, the results obtained by using the existing methods have no physical meaning; (3) The results obtained by the existing methods do not satisfy the constraints of fuzzy transportation problems exactly.

Limitations include: (1) Authors pointed out that there is no method in the literature to find the fuzzy optimal solution of an unbalanced fully fuzzy transportation problem; (2) There is no method in the literature to find the exact fuzzy optimal solution of fully fuzzy transportation problems; (3) Authors define a very interesting and unique idea, to solve fully fuzzy transportation problems with the help of tabular forms.

SECTION 4: INVENTORY CONTROL

Section four consists of three chapters. In Chapter 18, Huachun Xiong, Jinxing Xie, and Bo Niu provide the “Comments on Two Models for Operating Two-Warehouse Inventory Systems with Deteriorating Items and Inflationary Effects.” The authors mainly contribute to two-warehouse infinite-horizon inventory management for deteriorating products with inflationary effects in three aspects. First, the authors point out a critical point that when the inflationary effect is taken into consideration and the planning horizon is infinite, to minimize the discounted average cost in a unit time is unreasonable, and the objective function to be minimized should be the discounted total cost (the present value of all costs incurred) over the whole planning horizon. Second, the authors present an important observation that when the inflationary effect is considered for deteriorating products; all costs should be evaluated just at the exact time they occur. In particular, the relevant costs considered in this study include purchasing, holding, backlogging, and lost sales costs, and all of them should be calculated with caution. Third, the authors provided a rigorous proof that in terms of the discounted total cost, the operating model in which each cycle starts with shortages is less expensive to operate compared with the model in which each replenishment cycle starts with an instant replenishment and ends with shortages. The first and the second contributions clarify some misunderstandings among some modellers of inventory systems, and the third one provides helpful insights for managers of two-warehouse inventory systems. In addition to this, the mathematics techniques adopted in the proofs are innovative and thought-provoking, which might be also applicable in other researches.

In Chapter 19, S. R. Singh and Diksha Bhatia offer “An Integrated Vendor-Buyer Model with Uncertain Lead Time, Life Time under Inflation and Variable Holding Cost.” The series of firms that eventually make products and services available to consumers, including all the functions enabling the production, delivery and recycling of the materials, components, end products and services, is a supply chain. All
products reach the consumers via some kind of supply chain; some are much larger and complicated than the others. Within each organization, the supply chain includes all functions involved in receiving and fulfilling a customer request.

The uncertainty in the lead time of a supplier is such a phenomenon which has deep roots in reality. Almost every supplier faces this problem at some time or the other during his business deals. To date, most research has been done assuming a zero lead time. Needless to say, this is another unrealistic assumption, which considers that an order placed is completed instantaneously. But this is only possible if the supplier is always in possession of such a large amount of inventory that he does not take any time to fulfill a customer’s request. And this very assumption will put a lot of inventory holding cost on the supplier. Obviously, this is neither practical nor feasible. Hence, in the study, the existence of lead time is considered. This way, there is an element of uncertainty involved, which brings the study in close proximity to reality. Another area which is comparatively untouched is the concept of capital constraint for the supplier. However, as is very much evident from the face of facts, this constraint is very common. The lead time of the supplier is a probability density function of his managing cost. There is even an expiration date beyond which the product cannot be used. Hence, the retailer plans out his cycle to finish off his inventory before the product reaches its expiration date. The whole combination is very unique and very much practical. The setup has been explored numerically as well, an optimal solution has been reached at and the sensitivity of that solution has also been checked with respect to various system parameters.

R. P. Tripathi proposes an “EOQ Model with Time Dependent Demand Rate and Time Dependent Holding Cost Function” in Chapter 20. In the past few decades, many researchers have studied inventory models for deteriorating and non–deteriorating items. Inventory models have been developed for which the demand rate is constant, a function of the length of time an item is held in inventory or a function of the on hand stock. In this chapter, the author considers the continuous deterministic, infinite horizon, single item inventory system within the setting of a retailer sector in which the demand rate for an item is time dependent. The parameter of the replenishment cost is kept constant, but the carrying cost per unit is allowed to vary. The optimal policies are found, and decision rules and classical EOQ model are obtained by considering two different models. Numerical examples are given to illustrate the proposed models.

John Wang
Montclair State University, USA

Ruiliang Yan
Texas A&M University – Commerce, USA