

Preface

This volume is devoted to the presentation and discussion of state of the art studies in Mathematical Modeling, Computation and Optimization presented in the form of twenty chapters. It is a peer reviewed volume under the Platinum Jubilee Volume Series of Indian Statistical Institute. The topics of this volume display the emerging research trends in theory, computation and application of Mathematical Modeling to problems in statistics, economics, optimization and game theory. The collection of research articles in this volume exhibit the rich versatility of theories and a lively interplay between theory and significant applications in different areas. This volume contains some research articles which focuses on some exciting areas like model for wireless networks, model of Nash networks, dynamic model of advertising, application of reliability models in economics, support vector machines, optimization, complementarity modeling and games. This volume addresses issues associated with the interface of modeling and computation and it is hoped that the research articles will significantly aid in the dissemination of research efforts in these areas. Some pioneers of the field as well as some prominent younger researchers have contributed articles in this volume which are briefly mentioned below.

In Chapter 1, Andrey Garnaev considers modeling a Jamming Game for wireless networks in the framework of zero-sum games with linearized Shannon capacity utility function. The base station has to distribute the power fairly among the users in the presence of a jammer. The jammer in turn tries to distribute its power among the channels to produce as much harm as possible. This game can also be viewed as a minimax problem against nature. The author shows that the game has a unique equilibrium and also develops an efficient algorithm for this game which can find the optimal strategies in finite number of steps.

Chapter 2 by J. Derks, J. Kuipers, M. Tennekes and F. Thuijsman is about one-way flow connections model of unilateral network formation. The existence of Nash networks is proved for games where the corresponding payoff functions allow for heterogeneity among the profits that agents gain by the network. However when link costs are heterogeneous, it is shown by a counterexample that Nash networks do not always exist.

The aim of Chapter 3 by Reinoud Joosten is to model and to analyze strategic interaction over time in a duopolistic market in which advertising causes several types of externalities. Each period the firms independently and simultaneously choose whether to advertise or not. A new dynamic model of advertising in very general terms is formulated. A broad variety of long and short term externalities can be modeled by altering the (restrictions on the) parameters chosen. The author determines feasible rewards and (subgame perfect) equilibria for the limiting average reward criterion using methods inspired by the repeated games literature. Uniqueness of equilibrium is by no means guaranteed but Pareto efficiency may serve very well as a refinement criterion for wide ranges of the advertisement costs.

Unaware of the developments in each others areas, researchers in Reliability theory and Economics have been working independently. While some of the concepts from one area have direct interpretation in the other, there are many other notions which need further investigation. In Chapter 4, Subhash Kochar and Maochao Xu point out some interesting relationships that exist between some of the notions in Reliability Theory and Economics.

In Chapter 5, Theo S.H. Driessen introduces the notions of semi-null players and semi-dummy players in order to provide a new axiomatization for the Shapley value. A semi-null player is powerful as a singleton, but powerless by joining another nonempty coalition. According to the axiomatic approach to solutions, semi-null players receive the egalitarian payoff. It is shown that the Shapley value is the unique solution verifying semi-null player property, symmetry, efficiency, and linearity.

The purpose of Chapter 6 is to characterize operators on the set of real valued functions on a finite set which is coextrema additive. \mathcal{E} -coextrema additivity model by Atsushi Kajii, Hiroyuki Kojima and Takashi Ui provides a rich framework for analyzing effects of optimism and pessimism in economic problems.

Chapter 7 by T. S. Arthanari identifies a very important gap in economic/marketing modeling. In this chapter, the author critically looks at our capitalist market system, or the models used to predict market be-

behaviour and make market decisions, and wondering what happened to the main player, the consumer, in the system. Consumption is a key driver of the economy and assumptions are made about consumers in the models and the market place. This leads one to consider thought experiments, social dialogues, and models that stipulate the rightful place for the consumers as main players.

Drawing up an optimal advertising plan over time for a new product is an important field of study in marketing. The problem becomes more complex for new products that are part of the technological generations. Chapter 8 by A. K. Bardhan and Udayan Chanda deals with the determination of optimal advertising expenditure for two generation consumer durables. The model considers intergenerational diffusion effect and also introduces a framework for modeling innovation diffusion for two competing generations.

In Chapter 9, Anjana Gupta, Aparna Mehra and Davinder Bhatia employ a nonconvex separation theorem to scalarize the vector minimization problem subject to the constraint given in the form of set inclusion. A new Lagrange function is formulated for the scalarized problem. Saddle point criteria are developed which ensures the existence of the Lagrange multipliers. Lagrange duality results are also discussed in this chapter.

Semi infinite Programming refers to the class of problems involving infinite number of constraints while the number of variables remain finite. This model naturally arises in an abundant number of applications in different fields of mathematics, economics and engineering. In Chapter 10, Deepali Gupta and Aparna Mehra define the concept of approximate optimal solutions for semi infinite programming problems. The KKT type necessary optimality conditions, characterizing approximate optimal solutions are derived using the exact penalty function approach. Finally, the authors provide the bound on the penalty parameter in terms of dual variables so as to obtain an almost approximate solution for the primal semi infinite programming problem.

In Chapter 11, Oğuz Solyalı and Haldun Süral consider a one supplier - multiple retailers system over a finite planning horizon. Retailers have external demands for a single product and their inventories are controlled by the supplier based on order-up-to level inventory policy. The problem is to determine the time and the quantity of product to order for the supplier, the retailers to be visited in any period, the quantity of product to be delivered in these visits and the vehicle routes for deliveries so as to minimize system-wide inventory and routing costs. The authors present a Lagrangian

relaxation based solution procedure and implement the procedure on test instances.

In Chapter 12, K. K. Thampi and M. J. Jacob consider the probability and severity of ruin for a renewal class of risk process in which the claim inter occurrence times is generalized exponential. A closed form expression for the distribution of the deficit at ruin is obtained and the application of the results are illustrated with several examples.

Free riding occurs when players benefit from the actions and efforts of others without contributing to the costs incurred in generating the benefits. Typical situations where free riding may occur in the international arena are global warming abatement and management of international fish resources. Chapter 13 by Kim Hang Pham Do and Henk Folmer presents the feasible proportional allocation rule to discourage free riding for a special class of free riding problems. Some theoretical and practical properties of the rule are discussed. Applications to the management of the Baltic sea cod fishery and the Norwegian spring-spawning herring fishery are also presented.

The problem of resource extraction activity is of great interest and the competition among extractors can be modeled as a game. In Chapter 14, Luca Grilli studies a differential game for the extraction activity of a renewable good, in which players are overlapping generations. The framework of overlapping generations allows to consider intragenerational (players in the same generation) and intergenerational (players in different generations) game equilibria. The author introduces a Stackelberg differential game with asynchronous time horizons and non-fixed role structure. The overlapping generations framework results in the presence of two different behaviours, the myopic and the non-myopic behaviour. A possible solution for the myopic case is presented in this chapter.

Chapter 15 by Yogesh K. Agarwal and Prabha Sharma is devoted to the study of Optimal Communication Spanning Tree Problem (OCSTP). OCSTP is formulated as a mixed integer programming problem and Benders partitioning approach is applied for solving it. It is shown that after fixing the values of integer variables for defining a given tree, the dual of the resulting problem is very easy to solve. This dual solution is used to generate a cut for the Benders master problem. Rather than solving the master problem directly as an integer program, the authors use the standard local search algorithm to obtain an approximate solution. The algorithm proposed in this chapter evaluates the Benders objective function at each neighboring tree, and moves to the neighbor that minimizes this objective function. A cut for the master problem is generated from the new solution

and added to the master problem. It is shown that average solution quality produced by Benders search is significantly better than that produced by standard local search.

Sperners lemma is a well-known result in combinatorial topology and its most significant application is in proving Brouwer's fixed point theorem. An analogue of Sperners lemma with multiple, unrestricted labels is proved in Chapter 16 by R. B. Bapat. This extends a result due to Hochberg, McDiarmid and Saks obtained in the context of determining the bandwidth of the triangulated triangle.

In Chapter 17, Reshma Khemchandani, Jayadeva and Suresh Chandra propose a new incremental technique called Incremental Twin Support Vector Machines for training in batch mode. This technique is based on a newly developed classifier called Twin Support Vector Machines (TWSVM) classifier. Numerical implementation on several benchmark datasets has shown that the Incremental Twin SVM is not only fast, but also has good generalization.

Portfolio diversification (i.e., possessing shares of many companies at the same time for reducing risks) is considered to be an important task in the investors community to reduce the risk of a portfolio without not necessarily reducing the returns. Chapter 18 by Sanjeet Singh presents a classification study of different categories of companies on the basis of their various financial attributes using a quadratic optimization based classifier namely Support Vector Machine (SVM). This model is also used for sector wise classification of the company. To validate the performance, the results are compared with the ratings for companies provided by ICICI direct, a well-known trading website in Indian stock market. The comparison shows that the model generated by SVM is efficient and the results obtained using this technique are quite impressive.

In Chapter 19, Yasunori Kimura deals with a generalized proximal point algorithm for a sequence of m -accretive operators in Banach spaces. The author investigates the condition of coefficients more deeply, and obtains weak convergence of an iterative scheme with a weaker coefficient condition.

Complementarity model provides a unifying framework for several optimization problems. Modeling using a complementarity framework arises naturally for games, economics, engineering and management decision making problems. In Chapter 20, S. K. Neogy and A. K. Das present a survey on complementarity models in non-cooperative games and certain classes of structured stochastic game problems.

The 20 refereed articles contained in this volume are selected among the state of the art papers presented in the International Conference on Modeling, Computation and Optimization held during January 9–10, 2008 at Indian Statistical Institute, Delhi Centre. The conference was inaugurated by Professor S. K. Pal, Director, Indian Statistical Institute who also delivered the welcome address. There have been important new developments in the computational techniques of optimization and game problems. This conference was organized during the period of Platinum Jubilee Celebrations of the Indian Statistical Institute and it aimed at discussing new developments in the methods of decision making and to build an interaction between the academic model developers and practitioners by bringing them together to address the important issues in modeling, computation and optimization. It is the hope of the editors that this edited volume will have a seminal role to play in the journey of the development of theory and application of modeling computation and optimization.

S. K. Neogy, A. K. Das and R. B. Bapat
(Editors)