Editorial

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Biographical notes: Dr. Angappa Gunasekaran is a Professor of Operations Management in the Department of Management at the Charlton College of Business, University of Massachusetts-Dartmouth in USA. He has 175 papers published in 40 different peer-reviewed journals. He has presented over 50 papers and published about 50 articles in conferences. He is on the editorial board of 20 journals. He edits journals in operations management and information systems areas. He is currently interested in researching benchmarking, information technology/systems evaluation, technology management, logistics, and supply chain management.

I am pleased to introduce this inaugural issue of the *International Journal of Operational Research* (IJOR). IJOR proposes and fosters discussion on theory and applications of Operations Research (OR) and Management Science (MS) techniques and models. Globalisation of markets and operations incorporating e-commerce create complexity in the decision-making process in terms of determining suitable criteria, trade-offs and developing OR and MS models and solution techniques. Now, the real challenge is to make sure the development in OR and MS theory and applications is adequate for modelling and analysis of the so-called, "the new economy and enterprise environment". OR and MS theory and applications should be consistent with the phase with which the economy and enterprise environment changes. For example, problems such as how to optimise the advertising decisions in the internet or WWW and what criteria and constraints need to be considered in this new environment optimisation. Similar to this, how one can optimise the supplier selection and development given their implications on supply chain performance. Again, determination of suitable criteria and modelling techniques for the virtual enterprise environment that are primarily centred on strategic alliances, core competencies and information technology/systems will be a challenge.

The development in operations research and management science techniques should be tailored to the new economy and enterprise environment incorporating the advances in information technology. This poses a great challenge to the researchers and practitioners, to develop new theory and applications of operations research and management science. Also, new programming languages such as the object oriented programming and JAVA have kept up with the speed of the development in computer technologies. This has altered the traditional constraints present in the modelling and analysis of the optimisation problems in new economy and enterprise environments. It is not to say that the traditional OR and MS models and techniques are obsolete, but they need to be

developed further taking into account the advances in information technology and systems.

Considering the globalisation of services and manufacturing, a journal focusing on the global perspective of operations research and management science techniques is important. Developing suitable OR and MS models for computer-aided decision-support systems and in turn effective management of manufacturing and services is critical in the 21st century enterprise environment. This environment is characterised by an integrated supply chain, a network of firms through outsourcing, globalisation of manufacturing and service operations and the application of enterprise resource planning systems. Traditional optimisation criteria mainly focused on time and cost alone will not be the key criteria; therefore, this subject requires further investigation for optimisation in new enterprise environments. New operations research and management science techniques and applications will be the main focus of this journal. IJOR is aimed at shaping the future of operations research and management science theory and applications, considering the evolving new operations and enterprise paradigms.

Realising the importance of operations research models and techniques in the new enterprise environment, we felt that a journal dedicated to this field is a must. The main objective of the journal is to provide a platform for interaction between researchers and practitioners in operations research and management science theory and applications. It also aims to promote and coordinate developments in the field of decision-support systems, artificial intelligence and expert systems in new enterprise environments. The global dimension is emphasised with the objective of overcoming various cultural barriers and in turn to meet the needs of global markets. IJOR is to provide researchers and practitioners with the state of the art of operations research theory and applications in the current and future organisational environments. The journal acts as a vehicle to help professionals, academics and researchers, working in the field of operations research and management science, to disseminate information and latest developments and to learn from each other's research. The journal will publish original papers, review papers, book reviews and technical notes. Special Issues devoted to important topics in management science and operations research will occasionally be published.

This inaugural issue contains 12 papers discussing a range of issues dealing with operations research and management science theory models, techniques and applications in new enterprise environment. We provide a brief overview of the papers that appear in this issue.

Hasija, Pinker and Shumsky in their paper, 'Staffing and routing in a two-tier call centre', study two-tier service systems with gatekeepers who diagnose a customer problem and then either refer the customer to an expert or attempt treatment. The probability of successful treatment by a gatekeeper decreases as the problem's complexity increases. They determine the optimal staffing levels and referral rates that minimise the system costs, where these costs include staffing, customer waiting and mistreatment costs. They also compare the optimal gatekeeper system (a two-tier system) with a system staffed with only experts (a direct-access system). By drawing upon recent results showing the asymptotic optimality of square-root staffing rules for stand-alone queues, they show that the optimal design of a two-tier system can be reduced to determining an optimal referral rate. It is well known in the queuing literature that pooling resources can create economic benefits. However, in a two-tier system, it is not clear how to take advantage of pooling. They find that when waiting costs are high, having a direct-access system is preferred unless the gatekeepers have a high skill level.

If the gatekeepers' skills are high enough, it is optimal to achieve pooling economics at the first tier for even very high values of the waiting costs. Finally, they use numerical experiments to demonstrate that an easily computed referral rate from a deterministic system is a reasonable approximation for the optimal referral rate wherever a two-tier system is preferred to a direct-access system.

The paper, 'An M/G/1 retrieval queue with balking and retrials' by Wu, Hlynka, Brill and Wang considers an M/G/1 retrial queue with general retrial times. Customers may balk or renege at particular times. The server is subject to breakdown (with repairs). While the server is being repaired, the customer in service can either remain in the service position or leave and return, while maintaining its rights to the server. They find a stability condition for this system. In steady state, the joint distribution of the server state and queue length is obtained, leading to useful measures of the system, such as the probability of an empty system, the mean number of customers in the retrial queue and the expected retrial time.

Kozanidis, Melachrinoudis and Solomon in their paper, 'The linear multiple choice knapsack problem with equity constraints', introduce an important variation of a well-known problem, the Linear Multiple Choice Knapsack Problem with Equity Constraints, that finds application in the allocation of funds to highway improvements. The multiple-choice constraints are used to model the interactions that arise among different improvements. The equity constraints are introduced to ensure a balance on the budget amounts allocated to different sets of improvements. They present the mathematical formulation and show that this problem structure has several fundamental properties. These are used to develop an optimal two-phased greedy algorithm for its solution. They report computational results that indicate that the algorithm is more efficient than a commercial linear programming package and the outperformance increases with problem size.

The paper, 'Dynamic network flow models of sustainable grain silo location', by Foulds describes a number of new and interesting dynamic network flow models and solution techniques for the question of where to locate silo complexes for the storage of grain in relatively large rural, geographical grain producing areas. The models incorporate: total transportation costs, and capital investment, variable, and total costs for silo construction. Numerical examples and their optimal solutions are provided for each model. Comparisons are made between existing network models and those developed. Suggestions are made about suitable solution techniques for numerical instances of each model that is discussed. The paper represents a new approach to problems in a practical area of the location. Foulds believes that the models and techniques reported represent useful additions to the grain silo location planner's toolkit.

Satisfiability (SAT) and Max SAT problems have been the object of considerable research efforts over the past few decades. They remain a very important research area today due to their computational challenge and application importance. In their paper, 'Using the unconstrained quadratic program to model and solve Max 2 – SAT problems', Kochenberger, Glover, Alidaee and Lewis investigate the use of penalty functions to re-cast SAT problems into the modelling framework offered by the unconstrained quadratic binary program. Computational experience is presented illustrating how promising this approach is for Max 2-SAT problems.

The sport team realignment problem can be modelled as k-way equipartition: given a complete graph $K_n = (V, E)$, with edge weight c_e on each edge, partition the vertices V into k divisions that have exactly S vertices, so as to minimise the total weight of the

edges that have both endpoints in the same division. Ji and Mitchell in their paper, 'Finding optimal realignments in sports leagues using a branch-and-cut-and-price approach' discuss solving *k*-way equipartition problem using the branch-and-price scheme. They demonstrated the necessity of cutting planes for this problem and suggested an effective way of adding cutting planes in the branch-and-price framework. They solved the pricing subproblem as an integer-programming problem. Using this method, they found the optimal realignment solution for three major professional sports leagues in North America (basketball, hockey, football). They also present computational results on some larger randomly generated micro-aggregation problems.

Model selection is an important problem in mining information from large databases. For example, in selecting a regression model, there may be J independent variables giving 2^J feasible possible combinations of models from which to choose. Information criteria and information measure of complexity (ICOMP) criterion provide a method defining the 'best' solution, by providing an estimate of a measure of the difference between a given model and the true model. In their paper, 'An implicit enumeration algorithm for mining high dimensional data', Bao, Bozdogan, Chatpattananan and Gilbert introduce a new exact implicit enumeration (IE) algorithm to identify the subset of variables that minimises the information criterion. The IE algorithm uses efficient bounding strategies for the non-linear objective function of the model selection problem. In computational test, the IE algorithm outperforms the existing exact algorithms from the literature. The IE algorithm also has the advantage of being the only exact algorithm that can be used with all of the exiting information criteria, including ICOMP. ICOMP has the advantage that it explicitly takes into account the effect of the covariance of the variables on parameter estimation in the model selection process and it also makes no assumption that the parameter estimates are unbiased.

Hill and Hiremath in their paper, 'Improving genetic algorithm convergence using problem structure and domain knowledge in multidimensional knapsack problems', develop and test a new approach for generating initial populations for the application of genetic algorithms (GA) to problems in combinatorial optimisation, specifically the multi-dimensional knapsack problem. They focus the empirical study of our approach on a set of two-dimensional knapsack problems (2KP) used in a past study of 2KP algorithm performance. Their proposed approach for initial population generation focuses on generating populations that are stronger in terms of solution quality, solution diversity and in terms of solutions hovering near the border of feasible and infeasible solutions within the problem solution space. They report the results of a Monte Carlo experiment comparing our approach with the traditional initial population generation approach and report the results of computational tests involving 1,120 2KP instances that cover a range of problem constraint characteristics. The collection of these computational results show that our proposed approach provides an initial population of sufficient quality and diversity to produce improved convergence to near-optimal solutions that can equate to reduced computational burden in applications involving complex computations.

A controller area network (CAN) is a special-purpose communications system, used for real-time control of embedded components in vehicles and other general-purpose automation systems. Oliveira and Pardalos in their paper, 'A combinatorial algorithm for message scheduling', present a combinatorial algorithm based on network optimisation concepts for scheduling messages on a CAN. The message scheduling (CANMS) problem in CAN networks requires that messages be allocated according to their priorities, to prevent excessive delays on important messages. The CANMS is an

NP-hard problem. The objective of the proposed algorithm is to minimise the total time allocated for message occurrences, in order to avoid message loss. A graph construction is employed, transforming the original problem into the problem of finding cliques with restricted size. According to computer experiments conducted on representative instances, low latency schedules can be obtained through the use of the proposed algorithm. The low computational complexity of the procedure presents the possibility of efficiently solving larger instances of this NP-hard problem.

Based on the idea of dividing the task into several processes, Crespo and Maroto in their paper, 'Scheduling resource-constrained projects using branch and bound and parallel computing techniques', centre our interest on the techniques provided by parallel computing to solve the resource-constrained project scheduling problem, with the objective of obtaining a feasible schedule for the activities that minimises the total project length. The scheme that leads to the best results performs a static first-level decomposition of the solution tree, where processes search for a compromise between the benefits obtained after a parallel search and the communication and coordination costs implied. The contribution of the concept of *safe cutsets* has allowed the *cutset dominance rule* to be applied in a parallel implementation. Similar considerations will have to be taken into account when solving other problems by designing parallel branch and bound algorithms that use dominance rules that are only applicable when performing a depth-first search.

The Bayesian Network is a probabilistic graphical model in which a problem is structured as a set of parameters and probabilistic relationships among them. Researchers have effectively applied the Bayesian Network in many fields to incorporate the expert knowledge and data for updating the prior belief in the light of new evidence. However, there is inconsistency between priors and inference rules of a Bayesian Network in real settings. Chien in his paper, 'Modifying the inconsistency of Bayesian networks and a comparison study for fault location on electricity distribution feeder', aims to fill the gap for resolving the inconsistency problem involved in a Bayesian Network. In particular, a Bayesian Network on the basis of expert knowledge and historical data was constructed for fault diagnosis on a power distribution feeder. He also proposed a new method to modify the inconsistency between priors and inference rules of a Bayesian Network and compared it with the existing methods with real data. This study concludes with discussions on results and future research.

In information theory, entropy function is used to measure message uncertainty and communication channel capacity. Shannon entropy considers the probability distribution of signals transmitted over a given communication channel in its argument of uncertainty. Since the concept of the steady state of a queue (assuming it obtains) concerns a probability function, it seems logical to consider a connection between entropy and the uncertainty in queuing. Hence, using information-theoretic entropy, and the notions of steady state (SS) and steady-state distribution (SSD), the paper, 'An entropy measure of operating performance uncertainty in queues: Markovian examples', by Tirtiroglu presents an entropy-based uncertainty metric for measuring the operating performance of (Markovian) queues. M/M/1 and M/M/1/k models are used as examples. The proposed method offers the practical value of establishing how good (i.e., dependable) the long-run results for a queue are. This could be valuable for decision-making purposes especially when alternative models may be available to choose from. A model choice, which has less uncertainty, should be more desirable than one that

exhibits high uncertainty, since the latter would experience a more chaotic, more disorderly steady-state and long-run operating behaviour.

Modelling and optimisation have become an essential function of researchers and practitioners in a networked global economy. Globalisation of market and operations places a tremendous pressure on making timely and accurate decisions using the analysis of data and more accurate information. In the information intensive society and economy, decisions are made based on the analysis of data available. This highlights the importance of operations research and management science and the role of information technology. Operations research techniques and models need to be integrated with computers for the purpose of analysis, optimisation and application in decision making. These developments have led the researchers and practitioners to look for new operational research models and their applications in the global economy and society.

The *International Journal of Operational Research* is a refereed journal that acts as a forum for exchanging innovative ideas and sharing research and practical experiences in management science and operations research theory and applications. IJOR will focus on new theory development and applications in OR and MS. Some of the areas include: inventory models, queuing, transportation, game theory, scheduling, project management, mathematical programming, decision-support systems, multi-criteria decision making, artificial intelligence and expert systems, neural network and fuzz logic and simulation. Papers of the following types will be considered: analytical and simulations models, reviews on the state-of-the-art of OR and MS theory and applications and industry applications.

Academics and practitioners are invited to forward their contributions in the areas of management science and operations research theory and applications for possible publication in IJOR. Potential editors are welcome for guest editing special issues in emerging areas of operations research and management science. Please direct all your communication to the Editor-In-Chief (agunasekaran@umassd.edu). The following are the list of topics (but not limited to) that would be considered for publication in IJOR.

- information technology and operations research theory and applications
- effective use of scarce resources under dynamic and uncertain conditions
- decision theory and analysis
- probabilistic and stochastic models
- operations research techniques in finance and marketing
- manufacturing and operations theory and practice
- operations models in services
- logistics and OR models and techniques
- applications of operations research techniques
- military and operations research models
- operations research in public sector organisations
- statistics modelling
- OR and telecommunication and networking
- optimisation in operations research
- simulation.

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