Newsletter
of the INFORMS Computing Society

Contents

Message from the Chair

It is a great honor and responsibility to serve as the next Chair of the Informs Computing Society. Many thanks to outgoing chair David Woodruff for his tremendous service and his many contributions in leading the Society in the last two years. Dave: you will be a hard act to follow! Many thanks also to our outgoing Board members Sanjay Saigal and Hemant Bhargava, who have given to the Society in so many ways. And lastly, warm wishes to our two new Board members Arne Drud and Alexander Martin. Arne and Alex:

The Exploding Domain of Simulation Optimization

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1. Background and Importance.

The merging of optimization and simulation technologies has seen a remarkable growth in recent years. A Google search on "Simulation Optimization" returns more than six thousand pages where this phrase appears. The content of these pages ranges from articles, conference presentations and books to software, sponsored work and consultancy. This is an area that has sparked as much interest in the academic world as in practical settings.

A principal reason underlying the importance of simulation optimization is that many real world problems in optimization are too complex to be given tractable mathematical formulations. Multiple nonlinearities, combinatorial relationships and uncertainties often render challenging practical problems inaccessible to modeling except by resorting to simulation – an outcome that poses grave difficulties for classical optimization methods. In such situations, recourse is commonly made to itemizing a series of scenarios in the hope that at least one will give an acceptable solution. Consequently, a long standing goal in both the optimization and simulation communities has been to create a way to guide a series of simulations to produce high quality solutions, in the absence of tractable mathematical structures.

Applications include the goals of finding decision policies that optimize:

- machine utilization for production scheduling

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Letter From the Editor

By David L. Woodruff
ICS Chair and Acting Newsletter Editor

We were a little late with this one. Both a cause and an effect is all the great material that is here. Things are really happening in ICS-land. As you will read, we have a new slate of officers and some new directors. As you will read in the next newsletter, they are hard at work debating and refining a proposal for interest groups in the Society.

The feature article concerns a very important computational topic: the union of simulation and optimization. I'm using the word "union" here in the marital, rather than set, sense. To give us some perspective on where this is and where it is going, we are lucky to have one of the pioneers in our midst. Fred Glover has been an important contributor to the society in many ways. And, in fact, this is his second feature article for the newsletter.

If you have read this far, then you are serious about computing and OR. You should definitely plan to attend the ICS meeting in Annapolis in January. The ICS meeting has a history of excellence. This one promises to be the best ever. Take a look at the information we have here about the meeting and the venue. Annapolis is wonderful location, but that is less important to many of us than the history of important talks and very useful tutorials. The call for papers has gone out on many email servers, but I think most people don't read email these days, we use our email software strictly for email deletion.

This is my second-to-last issue as editor. If you have any interest in working with the newsletter in any capacity, please let me know. In particular, we are looking for a new editor. It's a fun and interesting job. I hope you enjoy the result of the effort this time.

Results of the INFORMS Computing Society Elections

1) Vice-Chair, Chair-elect: John Chinneck

2) Secretary-Treasurer: Robin Lougee-Heimer

3) Director through 2006:

Arne Stolbjerg Drud

Alexander Martin

Member Profile: Dr Sigurður Ólafsson

After obtaining a B.S. degree in Mathematics from the University of Iceland in 1994, Siggi Olafsson received his Ph.D. in industrial engineering from the University of Wisconsin – Madison in 1998. His research at the time involved design and analysis of a new approach to simulation-based optimization called the nested partitions method. He continues to work in this area, but has recently focused a great deal of his efforts on the emerging area of operations research and data mining. This includes both how large-scale data mining problems can be formulated and solved as optimization problems, and the use of data mining techniques to obtain data-driven solutions to traditional OR problem in areas such as planning and scheduling. Outside the data mining domain, he is interested in metaheuristics in general and in particular the use of metaheuristics for simulation-based optimization. Siggi is currently an Assistant Professor in the Department of Industrial and Manufacturing Systems Engineering at Iowa State University.

Siggi is active in several professional organizations. He is on the board of the Industrial Engineering Division of ASEE and he is the current Director of the Computer & Information Systems Division of IIE. He was also recently appointed the Newsletter Editor of the new INFORMS Section on Data Mining. Among other activities, he is currently editing a focused issue of the journal Computers and Operations Research on the topic "Operations Research and Data Mining," and writing a book on the nested partitions method with a colleague.

Within INFORMS, he believes that the Computing Society will continue to play a critical role in advancing new areas on the intersection on operations research and computer science. The relatively new field of data mining is a prime example of an area where cross-fertilization between these areas is of crucial importance. Data mining draws on traditional fields such as artificial intelligence, databases, statistics, and optimization to find meaningful patterns in very large databases. The ICS is a unique forum that brings together experts with interests in many of the fields most relevant to data mining, and Siggi feels that the synergy that can be created in such an environment will lead to significant advances in this area.

Proposed motto for ICS:

John Chinneck has proposed the motto "*ICS: INFORMS technology leading edge,*" for ICS that would provide a clear brief overview of INFORMS for attracting new membership. Please direct comments and suggestions to:

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Message: continued from page 1

welcome onboard.

2003 will be an exciting year for the ICS membership, with many planned activities.   Key among them will be the preparations for the 9th ICS Conference which will be held in Annapolis, January 5-7, 2005. The conference is organized by an august team of co-chairs that includes Bruce Golden, S. Raghavan, and Edward Wasil, and its theme is the "*Next Wave in Computing, Optimization, and Decision Technologies.*" Annapolis is a charming 17th century seaport less than an hour away from Washington DC and Baltimore. Whether you enjoy touring the historical town, shopping in the quaint stores, relaxing in the lively taverns or just wish to enjoy the beauty of the Chesapeake Bay, Annapolis has many attractions awaiting you. But of course the main attraction is the conference itself, and Bruce, Raghu, and Ed are lining up a very strong technical program. The Call for Paper is out at http://www.informs.org/Conf/Computing05/. I hope you will consider submitting a paper, either for the conference or just for presentation.

The INFORMS Meeting in Denver (October 24-27) is our other major activity for the year. The last INFORMS meeting in Atlanta was highly successful, with more than 20 ICS sponsored or cosponsored sessions. The sessions were a good mix of computational algorithms, modeling, software (including open source), computation in practice, applications and more.   We hope to achieve an even stronger participation this year. Please let me know if you wish to organize a session in the Computing Society Cluster. The deadline for submitting a session title is April 15.

Those of you who attended the Business Meeting in Atlanta know that the room was overflowing.   For the Denver meeting we were promised a larger room for the meeting. I do encourage you to come to the Business Meeting. It is a good occasion to network, to learn the latest about the Society, participate in the decision making, and help reshape the Society for the future. Refreshments will be on hand to give the meeting a pleasant and relaxed atmosphere.

In closing I encourage members to contact me with any suggestions or initiatives you may have for improving the Society.   See you in Denver!

Ariela Sofer

Member News

Anna Nagurney, the John F. Smith Memorial Professor at the Isenberg School of Management at UMASS, Amherst, has been appointed co-editor of the journal, Netnomics: Economic Research and Electronic Networking, along with Hans M. Amman, Professor of Computational Economics and Finance at the Technical University of Eindhoven, the Netherlands. Topics addressed by the journal include: pricing schemes for electronic services, electronic trading systems, data mining and high-frequency data, real-time forecasting, economic software agents, digicash-ecash systems, supply chains and e-commerce, supernetworks, as well as innovative related topics.

Additional information on the journal, which is published by Kluwer, and submissions can be found at: http://www.kluweronline.com/issn/1385-9587

Also, the book, "Innovations in Financial and Economic Networks," Anna Nagurney, editor, will be available in November 2003. The publisher of the volume is Edward Elgar Publishers, and the book is part of the New Dimensions in Networks series. This focused and refereed volume of contributions from leading scholars provides a wealth of innovations in the study of financial and economic networks. The contributors as well as the book chapters can be found at: http://supernet. som.umass.edu/bookser/ifen.htm

2003 ICS Prize For Research Excellence in the Interface between Operations Research and Computer Science

INFORMS Computing Society awards the 2003 ICS Prize for: Research Excellence in the Interface Between Operations Research and Computer Science to Ignacio Grossman for his many contributions to Nonlinear Mixed Integer Programming and Process Design.

Ignacio Grossman has made fundamental contributions to the theory and practice of mixed integer nonlinear programming (MINLP). His pioneering paper with Marco Duran on the Outer Approximation (OA) decomposition algorithm showed that it dominated Generalized Benders Decomposition for a large and important class of MINLP's. He was instrumental in developing the DICOPT implementation of OA, coupling it to the GAMS modeling language, and extending its logic to deal with problems that are non-convex in the continuous variables. DICOPT is now one of the most widely used MINLP solvers, and is largely responsible for making MINLP a viable tool for practical problem solving.

Professor Grossman has also made fundamental contributions in formulating industrially significant engineering design problems as optimization problems, with emphasis on the incorporation of logic-based modeling and algorithms. He has proposed useful measures of flexibility, and shown how to optimize flexible processes. He and his students developed ways to incorporate logical constraints into branch and bound logic which greatly speeded solution. His recent work on disjunctive programming and constraint programming maintains his high standards. In addition, he is widely recognized for his skills in recognizing and encouraging PhD students, many of whom have gone on to outstanding careers in academia and industry.

David L. Woodruff
INFORMS Computing Society Chair

Leon Lasdon
ICS Prize Committee Chair

János Pintér and Sanjay Saigal
Committee Members

- integration of manufacturing, inventory and distribution

- layouts, links and capacities for network design

- investment portfolios for financial planning

- utilization of employees for workforce planning

- location of facilities for commercial distribution

- operating schedules for electrical power planning

- assignment of medical personnel in hospital administration

- tolerances in manufacturing design

- treatment policies in waste management

and many other objectives.

In this paper, we first summarize some of the most relevant approaches that have been developed for the purpose of optimizing simulated systems. We then concentrate on the metaheuristic black-box approach that leads the field of practical applications and provide some relevant details of how this approach has been implemented and used in commercial software. Finally, we present an example of simulation optimization in the context of a simulation model developed to predict performance and measure risk in a real world project selection problem.

2. Technical Characteristics

The optimization of simulation models deals with the situation in which the analyst would like to find which model specifications (i.e., input parameters and/or structural assumptions) lead to optimal performance. In the area of design of

experiments, the input parameters and structural assumptions associated with a simulation model are called *factors*. The output performance measures are called *responses*. For instance, a simulation model of a manufacturing facility may include factors such as number of machines of each type, machine settings, layout and the number of workers for each skill level. The responses may be cycle time, work-in-progress and resource utilization. In this case we may seek to minimize cycle time by manipulating the number of workers and machines, while restricting capital investment and operational costs as well as maintaining a minimum utilization level of all resources.

In the context of simulation optimization, a simulation model can be thought of as a "mechanism that turns input parameters into output performance measures" (Law and Kelton, 1991). In other words, the simulation model is a function (whose explicit form is unknown) that evaluates the merit of a set of specifications, typically represented as set of values. Viewing a simulation model as a function has motivated the creation of a family of approaches to optimize simulations based *on response surfaces* and *metamodels*.

A response surface is a numerical representation of the function that the simulation model represents. A response surface is built by recording the responses obtained from running the simulation model over a list of specified values for the input factors. A response surface is in essence a plot that numerically characterizes the unknown function. Hence, a response surface is not an algebraic representation of the unknown function.

A metamodel is an algebraic model of the simulation. A metamodel approximates the response surface and therefore optimizers use it instead of the simulation model to estimate performance. Standard linear regression has been and continues to be one of the most popular techniques used to build metamodels in simulation. More recently, metamodels based on neural networks (Laguna and Martí, 2002), Kriging (van Beers and Kleijnen, 2003) and the Lever Method (April, et al., 2003) have also been developed and used for estimating responses based on input factors. Once a metamodel is obtained, in principle, appropriate deterministic optimization procedures can be applied to obtain an estimate of the optimum (Fu, 2002).

3. Classical Approaches for Simulation Optimization

Fu (2002) identifies 4 main approaches for optimizing simulations:

- · stochastic approximation (gradient-based approaches)
- · (sequential) response surface methodology
- · random search
- · sample path optimization (also known as stochastic counterpart)

Stochastic approximation algorithms attempt to mimic the gradient search method used in deterministic optimization. The procedures based on this methodology must estimate the gradient of the objective function in order to determine a search direction. Stochastic approximation targets continuous variable problems because of its close relationship with steepest descent gradient search. However, this methodology has been applied to discrete problems (see e.g. Gerencsér, 1999).

Sequential response surface methodology is based on the principle of building metamodels, but it does so in a more localized way. The "local response surface" is used to determine a search strategy (e.g., moving to the estimated gradient direction) and the process is repeated. In other words, the metamodels do not attempt to characterize the objective function in the entire solution space but rather concentrate in the local area that the search is currently exploring.

A random search method moves through the solution space by randomly selecting a point from the neighborhood of the current point. This implies that a neighborhood must be defined as

part of developing a random search algorithm. Random search has been applied mainly to discrete problems and its appeal is based on the existence of theoretical convergence proofs. Unfortunately, these theoretical convergence results mean little in practice where its more important to find high quality solutions within a reasonable length of time than to guarantee convergence to the optimum in a n infinite number of steps.

Sample path optimization is a methodology that exploits the knowledge and experience developed for deterministic continuous optimization problems. The idea is to optimize a deterministic function that is based on n random variables, where n is the size of the sample path. In the simulation context, the method of common random numbers is used to provide the same sample path to calculate the response over different values of the input factors. Sample path optimization owes its name to the fact that the estimated optimal solution that it finds is based on a deterministic function built with one sample path obtained with a simulation model. Generally, n needs to be large for the approximating optimization problem to be close to the original optimization problem (Andradóttir, 1998).

While these four approaches account for most of the literature in simulation optimization, they have not been used to develop optimization for simulation software. Fu (2002) identifies only one case (SIMUL8's OPTIMZ) where a procedure similar to a response surface method has been used in a commercial simulation package. Since Fu's article was published, however, SIMUL8 has abandoned the use of OPTIMZ, bringing down to zero the number of practical applications of the four methods mentioned above. Andradóttir (1998) gives the following explanation for the lack of practical (commercial) implementations of the methods mentioned above:

"Although simulation optimization has received a fair amount of attention from the research community in recent years, the current methods generally require a considerable amount of technical sophistication on the part of the user, and they often require a substantial amount of computer time as well."

Leading commercial simulation software employs metaheuristics as the methodology of choice to provide optimization capabilities to their users. We explore this approach to simulation optimization in the next section.

4. Metaheuristic approach to simulation optimization

Nowadays nearly every commercial discrete-event or Monte Carlo simulation software package contains an optimization module that performs some sort of search for optimal values of input parameters rather than just perform pure statistical estimation. This is a significant change from 1990 when none of the packages included such a functionality.

Like other developments in the Operations Research/Computer Science interface (e.g., those associated with solving large combinatorial optimization problems) commercial implementations of simulation optimization procedures have only become practical with the exponential increase of computational power and the advance in metaheuristic research. The metaheuristic approach to simulation optimization is based on viewing the simulation model as a black box function evaluator.

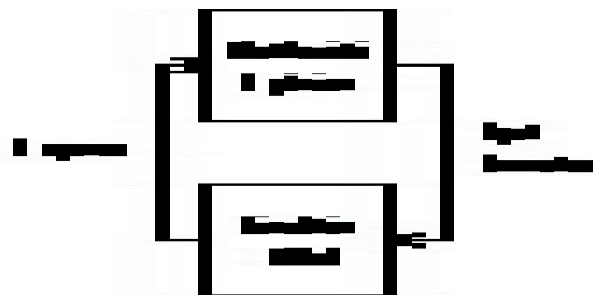Figure 1 shows the black-box approach to simulation optimization favored

Figure 1: Black box approach to simulation optimization

by procedures based on metaheuristic methodology. In this approach, the metaheuristic optimizer chooses a set of values for the input parameters (i.e., factors or decision variables) and uses the responses generated by the simulation model to make decisions regarding the selection of the next trial solution.

Most of the optimization engines embedded in commercial simulation software are based on evolutionary approaches. The most notable exception is the optimization algorithm in WITNESS, which is based on search strategies from simulated annealing and tabu search. (Incidentally, simulated annealing may be viewed as an instance of a random search procedure; its main disadvantage is the computational time required to find solutions of a reasonably high quality.)

Evolutionary approaches search the solution space by building and then evolving a population of solutions. The evolution is achieved by means of mechanisms that create new trials solutions out of the combination of two or more solutions that are in the current population. Transformation of a single solution into a new trial solution is also considered in these approaches. Examples of evolutionary approaches utilized in commercial software are shown in Table 1.

Table 1: Commercial Implementations of Evolutionary Approaches to Simulation Optimization

Optimizer	Technology	Simulation Software
OptQuest	Scatter Search(& Tabu Search)	AnyLogic Arena Crystal Ball CSIM19 Enterprise Dynamics Micro Saint ProModel Quest SimFlex SIMPROCESS SIMUL8 TERAS
Evolutionary Optimizer	Genetic Algorithms	Extend
Evolver	Genetic Algorithms	@Risk
AutoStat	Evolution Strategies	AutoMod

We have enclosed Tabu Search in parentheses following the listing of Scatter Search because these two methods derive from common origins and are frequently coupled, as they are in OptQuest. (See Glover, Laguna and Marti, 2003.) The main advantage of evolutionary approaches in general over those based primarily on sampling the neighborhood of a single solution (e.g., simulated annealing) is that they are capable of exploring a larger area of the solution space with a smaller number of objective function evaluations, provided they are implemented effectively. Since in the context of simulation optimization evaluating the objective function entails running the simulation model, being able to find high quality solutions early in the search is of critical importance. A procedure based on exploring neighborhoods would be effective if the starting point is a solution that is "close" to high quality solutions and if theses solutions can be reached by the move mechanism that defines the neighborhood.

The methods that are designed to combine solutions in an evolutionary metaheuristic approach depend on the way solutions are represented. Complicated problems have mixed solution representations with decision variables represented with continuous and discrete values as well as permutations.

5. Use of Metamodels

Metaheuristic optimizers typically use metamodels as filters with the goal of screening out solutions that are predicted to be inferior compared to the current best known solution. Laguna and Martí (2002) point out the importance of using metamodels during the metaheuristic search for the optimal solution:

"Since simulations are computationally expensive, the optimization process would be able to search the solution space more extensively if it were able to quickly eliminate from consideration low-quality solutions, where quality is based on the performance measure being optimized."

Some procedures use neural networks to build a metamodel and then apply predefined rules to filter out potentially bad solutions. The main issues that need to be resolved in an implementation such as this are:

- the architecture of the neural network
- data collection and training frequency
- filtering rules

The architecture of the neural network must be general enough to be able to handle a wide variety of situations, since the trained neural network becomes the metamodel for the simulation model that evaluates the objective function.

In addition to neural networks, a new type of metamodel called the Lever Method (April, et al., 2003) has recently been developed that is incorporated within the OptQuest engine. The architecture of the system implicitly consists of a mixed integer programming model that is adaptively generated and revised as new solutions are uncovered that give additional information about the characteristics of the solution space.

Metamodels can also be used as a means for generating new trial solutions within a metaheuristic search. For example, the Lever Method not only provides a mixed integer representation but makes it possible to generate piecewise linear subregions (typically nonconvex) that approximate the shape of critical areas of the space where improved solutions are likely to be found. Figure 2 depicts the metaheuristic optimization process with a metamodel filter, where the metamodel gives a function evaluation $F(x)$ as an estimate of the "true" evaluation $f(x)$ given by the simulation process.

Figure 2: Metaheuristic optimizer with a metamodel filter
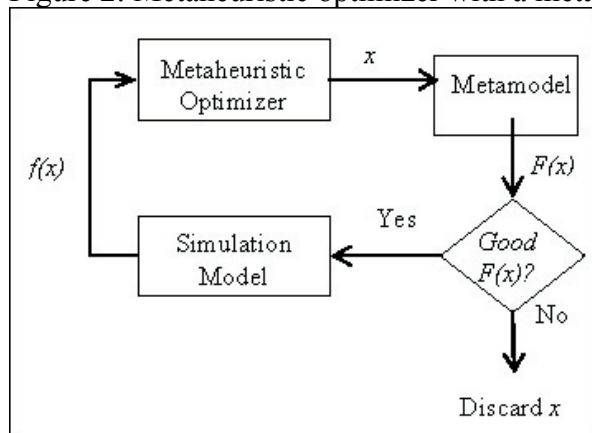
6. Constraints

An important feature in simulation optimization software is the ability to specify constraints. Constraints define the feasibility of trial solutions. Constraints may be specified as mathematical expressions (as in the case of mathematical programming) or as statements based on logic (as in the case of constraint logic programming). In the context of simulation optimization, constraints may be formulated with input factors or responses.

Suppose that a Monte Carlo simulation model is built to predict the performance of a portfolio of projects. The factors in this model are a set of variables that represent the projects selected for the portfolio. A number of statistics to define performance may be obtained after running the simulation model. For instance, the mean and the variance on the returns are two responses that are available after running the simulation. Percentile values are also available from the empirical distribution of returns. Then, an optimization problem can be formulated in terms of factors and responses, where one or more responses are used to create an objective function and where constraints are formulated in terms of factors and/or responses.

If the constraints in a simulation optimization model depend only on input parameters then a new trial solution can be checked for feasibility before running the simulation. An infeasible trial solution may be discarded or may be mapped to a feasible one when its feasibility depends only on constraints formulated with input parameters.

On the other hand, if constraints depend on responses then the feasibility of a solution is not known before running the simulation. In the application described in the next section, for example, a constraint that specifies that the variance of the returns should not exceed a desired limit cannot be enforced before the simulation is executed.

7. Budget-Constrained Project Selection Example

We illustrate the benefits of simulation optimization applied to a project selection problem by using Crystal Ball for the simulation and OptQuest for the optimization. The problem may be stated as follows. A company is considering investing in 5 different projects and would like to determine a level of participation in each project:

- Tight Gas Play Scenario (TGP)
- Oil – Water Flood Prospect (OWF)
- Dependent Layer Gas Play Scenario (DL)
- Oil - Offshore Prospect (OOP)
- Oil - Horizontal Well Prospect (OHW)

The company has information regarding the cost, probability of success and estimated distribution of returns for each project. The company also knows that the total investment should not exceed a specified limit. With this information, the company has built a ten-year Monte Carlo simulation model that incorporates different types of uncertainty.

A base optimization model is constructed where the objective function consists of maximizing the expected net present value of the portfolio while keeping the standard deviation of the NPV to less than 10,000 M$. The base model has 5 continuous variables bounded between 0 and 1 to represent the level of participation in each project. It also has two constraints, one that limits the total investment and one that limits the variability of the returns. Therefore, one of the constraints is solely based on input factors and the other is solely based on a response. The results

from optimizing the base model with OptQuest are summarized in Figure 3.

Figure 3: Results for base case
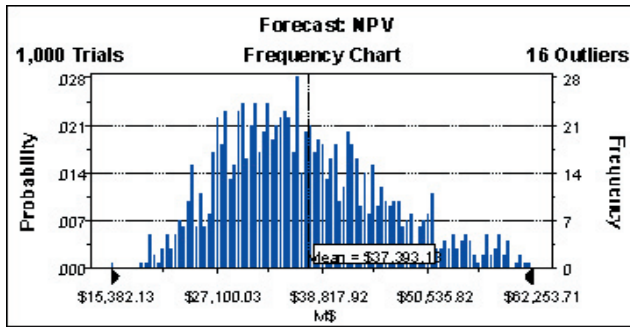
TGP = 0.4, OWF = 0.4, DL = 0.8, OHW = 1.

E(NPV) = 37,393   s =9,501

The company would like to compare the performance of the base case with cases that allow for additional flexibility and that define risk in different ways. Hence, we now formulate a "deferment" case that consists of allowing the projects to start in any of the first three years in the planning horizon of 10 years. The number of decision variables has increased from 5 to 10, because now the model must choose the starting time for each project in addition to specifying the level of participation. It is interesting to observe that in a deterministic setting, the optimization model for the deferment case would have 15 binary variables associated with the starting times. The model also would have more constraints than the base mode, in order to assure that the starting time of each project occurs in only one out of three possible years. Let y_{it} equal 1 if the starting time for project i is year t and equal 0 otherwise. Then the following set of constraints would be added to a deterministic optimization model:

$$y_{11} + y_{12} + y_{13} = 1$$
$$y_{21} + y_{22} + y_{23} = 1$$
$$y_{31} + y_{32} + y_{33} = 1$$
$$y_{41} + y_{42} + y_{43} = 1$$
$$y_{51} + y_{52} + y_{53} = 1$$

However, in our simulation optimization setting, we only need to add 5 more variables to indicate the starting times and no more constraints are necessary. The only thing that is needed is to account for the starting times when these values are passed to the simulation model. If the simulation model has the information regarding the starting times, then it will simulate the portfolio over the planning horizon accordingly. The summary of the results for the deferment case is shown in Figure 4.
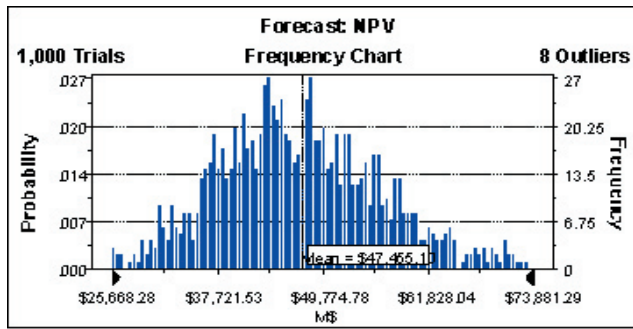
Figure 4: Results for deferment case

$$TGP_1 = 0.6, DL_1 = 0.4, OHW_3 = 0.2$$

E(NPV) = 47,455   ó =9,513   10th Pc.=36,096

Comparing the results of the deferment case and the base case, it is immediately evident that the flexibility of allowing for different starting times has resulted in an increase in the expected NPV. The new portfolio is such that it delays the investment on OHW until the third year and it does not invest anything on OWF, for which the level of participation was 40% in the base case. The results in Figure 4 also show that the 10th percentile of the distribution of returns is 36,096 M$. This information is used to model our third and last case.

Encouraged by the results obtained with the model for the deferment case, the company would like to find both the participation levels and the starting times for a model that attempts to maximize the probability that the NPV is 47,455 M$. This new "Probability of Success" model changes the definition of risk from setting a maximum on the variability of the returns to maximizing the probability of obtaining a desired NPV. The new model has the same number of variables and fewer constraints as the previous one, because the constraint that controlled the maximum variability has been eliminated. The results associated with this model are shown in Figure 5 (see following page).

Figure 5: Results for probability of success case
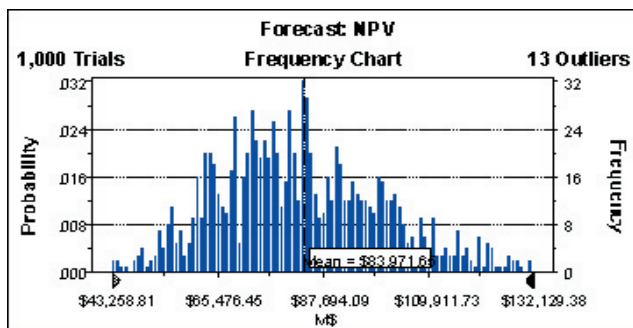
$$TGP_1 = 1.0, OWF_1 = 1.0, DL_1 = 1.0, OHW_3 = 0.2$$

E(NPV) = 83,972   ó =18,522

P(NPV > 47,455) = 0.99

The results in Figure 5 show that the new optimization model has the effect of "pushing" the distribution of NPVs to the right, i.e., to the larger returns. Therefore, although the variability has exceeded the limit that was used in the base case to control risk, the new portfolio is not more risky

than the first two considering that with a high probability the NPV will be at least as large as the expected NPV in the deferment case. In fact, the 10th percentile of the new distribution of returns is larger than the one in Figure 4.

8. Conclusions

We have introduced the key concepts associated with the area of optimizing simulations, starting with the approaches that researchers have investigated for many years. For the most part, these approaches have not found use in commercial software.

We then discussed the metaheuristic approach to simulation optimization, which is the approach widely used in commercial applications. Key implementation factors, in addition to the fundamental strategies underlying the metaheuristic, are the solution representation, the use of metamodels and the formulation of constraints.

Finally, we provided a project selection example that showed the advantage of combining simulation and optimization. The level of performance achieved by the solutions found with optimization far exceeds that to be derived from a manual what-if analysis because of the overwhelmingly large number of possible scenarios that must be considered.

There is still much to learn and discover about how to optimize simulated systems both from the theoretical and the practical points of view. The rich variety of practical applications and the dramatic gains already achieved by simulation optimization insure that this area will provide a growing source of practical advances in the future.

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 The issues in computational modeling of music have risen to the forefront due to the entertainment sector's interests in music recommendation (personalized systems for online retrieval of music) and performance rendering systems (affecting the movie scoring and music industries). The need for new algorithms and models better to understand, compute, and evaluate the structure and effects of music is made more urgent by the rapid proliferation of digital music. Many problems in computer-based methods for content analysis and feature extraction, similarity assessment and classification, and generative methods for creating music can be and have been solved using core OR approaches.

 We invite papers that highlight the use of computational operations-research techniques in analysis and generation of music. The broad topic areas include, but are not limited to, computational modeling of music perception and cognition, music information retrieval, computer-assisted composition, and interactive music systems. The goal of the cluster is to introduce computational research in music to the OR community at large. As such, *the papers should not only feature the contributions of the author(s) to the domain but also provide a clear and expository review of key advances in the specialty area and identify or define some concrete and open problems*.

 By operations-research techniques, we mean mathematical, statistical, and computational methodologies defined and documented in the OR literature, such as mathematical programming (linear, nonlinear, integer), network models, and other deterministic techniques; dynamic programming, Markov chains, queuing theory, and other stochastic processes; and more recent inventions such as genetic and evolutionary algorithms, simulation, neural networks, approximation algorithms, and domain-specific heuristic methods.

 Some sample (and overlapping) topics include the following:

• **Music representation and comparison.** Includes various ways to represent music and the reliability and accuracy issues associated with each representation, and ways to detect and assess similarity for classification and categorization. Methods in use include clustering and mathematical-programming techniques and combinatorial approaches. Algorithmic efficiency and scalability is an important issue with rapidly expanding digital databases.

• **Tonal structure and function**. Topics include recognition and prediction of pitch structures and functions, such as key-finding, tonal partitioning, and chord analysis. Existing methods include linear and dynamic-programming techniques, linguistic approaches, and neural network models. Determining accurate solutions to the problems is challenging due to uncertainty, for example, incom-

plete or extraneous information.

•   **Time structure detection and prediction.** An essential part of music is the beat and meter. Recognition problems related to these time structures include beat tracking, meter induction, and rhythm analysis. Methods include tree-based approaches, multi-hypothesis evaluations, rule-based methods, and neural networks.

•   **Computer-assisted composition and improvisation.** Stochastic methods for generating viable solutions in a large solution space have long been employed in music composition. Other techniques include network models, constraint programming approaches, genetic and evolutionary algorithms, and Markov-chain models.

•   **Performance-rendering systems.** Performance is the manipulation of a variety of factors such as timing of beats, dynamics, and articulation. An interpretation is the result of one particular sequence of inter-related decisions. Existing methodology for generating expressive performances include case-based reasoning, neural networks, and probabilistic approaches.

The _INFORMS Journal on Computing_ is a publication of the Institute for Operations Research and the Management Sciences (INFORMS). The _JoC_ publishes results in the intersection of operations research and computer science.

Deadline for Submission: February 16, 2004 (new!)
Please see Instructions for Authors.

You can submit electronically a postscript or pdf file to the Editor, or to any of the Associate Editors with Cc: _echew@usc.edu_. _Direct your questions to:_

> Elaine Chew
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Please post and distribute this announcement freely. _Last update: January 15, 2004._

FIRST CALL FOR PAPERS
The Ninth INFORMS Computing Society Conference
NEXT WAVE IN COMPUTING, OPTIMIZATION, AND DECISION TECHNOLOGIES

January 5-7, 2005
Loews Annapolis Hotel
Annapolis, Maryland

The INFORMS Computing Society (ICS) solicits papers and presentations for its ninth conference on the interface of computer science (CS), artificial intelligence (AI), operations research, and management science (OR/MS). The conference organizers invite you to submit theoretical and applied work that highlights the conference theme. Specific areas of interest include (but are not

limited to) design and analysis of algorithms, heuristic search and learning, modeling languages, parallel and distributed computing, simulation, computational logic, and visualization. Work that focuses on new or novel applications in the interface of CS, AI, and OR/MS is especially welcome.

SUBMISSIONS

There are two categories of submissions:

(1) papers for the conference volume

(2) papers for presentation.

Papers for the Conference Volume

A volume of peer-reviewed papers will be published for distribution at the conference. A paper submitted for the conference volume must describe original work that has not been published previously and must not have been submitted for publication elsewhere. A paper for the conference volume is limited to 6,000 words, will be refereed, and should be submitted by email as a PDF file. After acceptance for publication, authors will prepare their paper for the conference volume using a style format supplied by the publisher. A paper accepted for the conference volume must be presented at the conference.

Papers for Presentation

A paper may be submitted only for presentation at the conference and will not appear in the conference volume. An abstract of less than 200 words should be submitted by email as a PDF file. A paper accepted for presentation will have the abstract printed in the conference program.

IMPORTANT DATES

Papers for Conference Volume
Submission deadline   May 10, 2004
Notification of acceptance   July 2, 2004
Final papers due   August 2, 2004

Abstracts for Presentations
Submission deadline   September 17, 2004
Notification of acceptance   October 1, 2004

CONFERENCE DETAILS

For conference information, visit http://www.informs.org/Conf/Computing05.
For ICS information, visit http://computing.society.informs.org.
The conference organizers can be contacted at ics2005@rhsmith.umd.edu.

Bruce Golden   S. Raghavan   Edward Wasil

Conference Co-Chair   *Conference Co-Chair*   *Conference Co-Chair*

R.H. Smith School of Business   R.H. Smith School of Business   Kogod School of Business

University of Maryland   University of Maryland   American University

Report on *INFORMS Journal on Computing*

David Kelton, Editor-in-Chief (via John Chinneck)
Oct. 2003, Atlanta conference, ICS business meeting

- Publication of Volume 15 (2003)
    - All four issues on time
    - 22 papers, 444 pages (budget = 448 pages), essentially the same as last year
    - 2nd issue: *Special Issue on Mining Web-Based Data for e-Business Applications*, Guest-Co-Edited by Louiqa Raschid and Alex Tuzhilin
- Flow of papers – over last 12-month period
    - 124 submissions (up 49% from 86 in prior 12 months)
    - Finished processing on 103 papers, of which 36 (35%) were acceptances
- Prior 12 months: Finished processing 89 papers, 40% accepted
    - Backlog stands at 36 papers (after 4th 2003 issue)
    - This backlog is well over a year's worth of material, so a 64-page increase for next year has been requested
- Special issues, special papers in the works
    - Special Issue on OR and Computational Biology (Harvey Greenberg)
    - Special Issue on OR in Electrical and Computer Engineering (John Chinneck)
    - Special Cluster of papers on Computation in Music (Elaine Chew)
    - Two Feature Articles (Ed Wasil)
- Website
    - Still very plain, but is functioning well
- Preparing manuscripts, forthcoming papers, Area editorial statements, roster of all people, back issues, online supplements (grew from four to 12)
    - Unadvertised site for internal procedures
- Referees, Associate Editors, Area Editors, Editor-in-Chief
    - Ongoing project for an online subject/keyword index for entire history of journal (about half done now ... got an internal university grant for help)
    - Still no need for online submission forms, reviewing, tracking
- Acquired a decent scanner this year so now even copyedited papers are transmitted electronically
- Areas and Personnel
    - Closed High-Performance Computation Area
- In-process papers transferred to other Areas
- Topics absorbed into other Areas, naturally or by design
- Considerable discussion and general agreement (though not unanimous)
    - Jan Karel Lenstra stepped down after 15 years as Area Editor for Design and Analysis of Algorithms, dating back to the birth of JOC in 1989 (*applause, please*) ... becoming General Director of CWI
- Replaced by Bill Cook, Georgia Tech
    - No Associate Editors stepped down
    - Six new Associate Editors appointed
- Production
    - Continues to move very smoothly
    - Thanks to authors for formatting and supplying good files
    - Page proofs are almost always almost perfect

–INFORMS has brought production in-house, via a key hire, Dr. Mirko Janc

•Expert in LaTeX

•Has made noticeable improvements in layout, graphics, tables

•Finances

–Close of 2002: revenue = $120K, expenses = $73K

•The $73K expenses include $9K overhead to INFORMS

•Institutional Sponsorship at $2500, down from $3500

–Through September in 2003: revenue = $72K, expenses = $45K

•Circulation

–Total = 1,755

•= 952 IPOL suite + 803 *JOC*-only (union of print, online)

•The 803 includes 273 libraries, down from 297 last year

•Total is down 8% from last year

•Citations

–ISI Impact Factor = 0.979 for 2002

•Up from 0.729 in 2001, estimated 0.308 in 2000

•Was not indexed by ISI prior to 2000

•Unusual for a journal to jump by > 0.2 in a year

–7th of 54 "OR & MS" journals that ISI indexes

•Up from 8th of 53 in 2001, 24th of 50 in 2000

–2nd among INFORMS journals (two others right behind)

–*Personal opinion*: This is good news and we'll take it, but such indices and
   rankings have their defects ...

•Plans

–Maintain high submission, throughput rates

–Work off some of backlog if page-budget increase is approved

–Complete online global keyword-index project