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THE INSTITUTE OF MANAGEMENT SCIENCES

NEWSLETTER

President's Message

The last page of this issue of the *Newsletter* contains a ballot for the election of new College Officers. I urge each member of the College to cast his vote by marking the ballot, detaching it, and returning it to me. Note that each ballot is validated by the mailing label on the ballot, so it is necessary to return the entire page containing the ballot and the mailing label.

With this message I am ending my term as President of the College. I want to take this opportunity to thank some of the people who have been instrumental in planning and carrying out the numerous activities of the College over the past two years. I thank David Kelton, the Vice President, for organizing College-sponsored sessions at the joint national TMS/ORSA meetings. As Secretary-Treasurer, Barry Nelson has carefully managed our financial resources during some exceptionally prosperous years. Special thanks go to Dave Goldsman and Jim Swain, the *Newsletter* Co-Editors, for their extraordinary efforts in producing the *Newsletter* during this period. As I have often said in College Business Meetings, I believe that two of the most important functions of the College are performed by the Publication Award Committee and the Service Award Committee. For the past two years, the following individuals have served on the Publication Award Committee: Gordon Clark, Doug Miller, Steve Roberts, Peter Welch, and Dave Withers. During this period, the Service Award Committee has included Bill Biles, Bob Sargent, Bruce Schmeiser, Tom Schriber, and Lee Schruben. The successful operation of the College over the past two years is mainly due to the conscientious efforts of these people, and I sincerely appreciate their contributions.

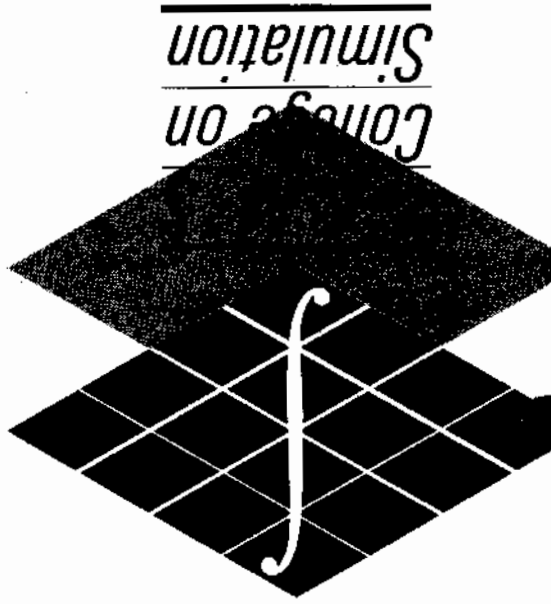
As we look to the future, I want to suggest some activities to consider.

Over the past year, I have come to the conclusion that the *Newsletter* provides the only means of reaching a substantial portion of the College membership; and thus we should constantly seek new ideas for improving the content and format of the *Newsletter*. The increased emphasis on the role of the *Newsletter* has (I hope) become clear over the past year, and I trust that this trend will continue in the future. In the same vein of seeking effective means for reaching out to the College membership, I suggest that the College sponsor the establishment of an electronic bulletin board service for simulation, perhaps with separate areas for College activities, public-domain software, technical reports, and a directory of electronic mail addresses of College members. Finally, I want to reiterate my suggestion that

Continued on page 2

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TIMS College on Simulation Newsletter is published twice each year, in the Spring and Fall, by TIMS College on Simulation. Membership in the College on Simulation is independent of membership in The Institute of Management Sciences. Annual dues for non-TIMS members is \$3; TIMS members may join for \$2. Dues for those outside of the U.S./Canada is \$3.

To join, send name, address, e-mail address (if applicable), and the appropriate dues to: Barry Nelson, Dept. of Industrial and Systems Engineering, The Ohio State University, Columbus, OH 43210. Make checks payable to "TIMS College on Simulation." If you know people who might be interested in joining, please pass along this announcement.

Bulk rate postage paid at Atlanta, GA and additional mailing offices. POSTMASTER: Send address changes to **TIMS College on Simulation Newsletter**, 290 Westminster St., Providence, RI 02903.

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President's Message (Continued from page 1)

the College consider sponsoring the publication of a monograph series on topics in the field of simulation. All of these ideas as well as others require advocates within the College—that is, interested members who will (perhaps single-handedly and single-mindedly) take on the responsibility for bringing new ideas to fruition. Knowing that the membership includes many capable and dedicated individuals who are willing to serve in such roles, I look forward with confidence to the future of the College.

—James R. Wilson, President
TIMS College on Simulation

The aim of the **Newsletter** is to provide the members of the College with information about the business of the College and on topics of common interest. The scope and appearance of the **Newsletter** have been evolving over the last several issues, and we hope that the **Newsletter** will be an important and useful publication for the members.

This issue marks a number of changes for the **Newsletter**. To enhance its appearance and readability, the **Newsletter** has been professionally produced by Lionheart Publishing. In addition, advertisements are now being accepted to showcase simulation products and to support part of the increased costs of publication. We welcome any comments or suggestions about the content or the format.

In order to increase visibility for the College, this issue is being sent to all attendees of the 1989 Winter Simulation Conference. This issue will also be handed out to attendees of relevant upcoming conferences. A "tear-out" sheet has been provided for those who wish to join the College. As always, please send abstracts and other material to the **Newsletter** editors for inclusion in the next issue. Editorial deadline for the Fall issue is September 1, 1990.

— dg & jjs

Editor's Corner

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```

vehicleobj = OBJECT
course: [ 0 .. 359 ];
speed: INTEGER;
position: LOCTYPE;
TELL METHOD Proceedto (IN Dest: LOCTYPE);
ASK METHOD Stop;
END OBJECT;

Aircraftobj = OBJECT (vehicleobj, graphicsobj);
altitude: INTEGER;
OVERRIDE
ASK METHOD Stop;
END OBJECT;
    
```

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Minutes of College Meeting at ORSA/TIMS in New York

Attending: Peter Glynn, Dave Goldsman, Christos Alexopoulos, Bin Zhang, Lee Schruben, Michael Fu, Jian-Qiang Hu, Russell Barton, Michael Ketcham, Ingrid Stahl, Gerry Felgin, Phil Heidelberger, Gordon Clark, Jim Wilson and Bob O'Keefe.

1. The meeting was called to order by Jim Wilson at 6:20 PM on October 16, 1989.

2. The Treasurer's report and the minutes of the business meeting at the CORSA/TIMS/ORSAs Vancouver meeting were read and approved.

3. The ongoing Student Presentation Award was discussed, but all motions were tabled until the next College meeting.

4. Jim Wilson announced that Doug Miller will replace Gordon Clark as a member of the Outstanding Publication Awards Committee. He also announced that the deadline for nominations for next year's Award has been extended to January 31, 1990; and he urged all College members to forward nominations to Peter Welch, the Chairman of the Publication Awards Committee.

5. Lee Schruben submitted a motion on behalf of Bob Sargent that the name of the Outstanding Service Award be changed to the Distinguished Service Award. The motion passed.

6. Jim Wilson gave an update on the status of the Simulation Department of *Management Science*, for which he is Departmental Editor.

7. The registration fee for the Winter Simulation Conference was discussed.

8. The meeting was adjourned at 6:45 PM.

Respectfully submitted,
Barry L. Nelson

Secretary-Treasurer

Minutes of College Meeting at WSC '89

Members attending: Jim Wilson, Mike Taaffe, Paul Sanchez, Tom Schriber, Jack Kleijnen, Steve Roberts, Lee Schruben, David Britskman, Enver Yucesan, Sheldon Jacobson, Susumu Morito, Gordon Clark, Robert Sargent, Thomas Clark, Ken Musselman, Arne Thesen, Andy Sella, Russell Barton, Pierre L'Ecuuyer, Peter Glynn, Dave Goldsman, Susanne Norton, Barry Nelson, Mingjian Yuan, Der-Fa Robert Chen, Whyeming Tina Song, Bruce Schmeiser, Pandu Tadikamalla, Diane Bischak, Dean Hartley, Jim Swain.

Nonmembers attending: Ward Whit, Russell Cheng, B.J. Schroer, F.T. Tseng, Shou-Xiang Zhang, Wei-Ning Yang, Chuck Reilly, Bridget Moore, Lynne Goldsman, Manuel Rossetti.

1. The meeting was called to order by Jim Wilson at 5:20 PM on December 5, 1989.

2. The Treasurer's report and the minutes of the business meeting at the ORSA/TIMS New York meeting were read and approved.

3. David Kelton reported that there will be seven college-sponsored sessions at TIMS/ORSAs Las Vegas, and three to four sessions at ORSA/TIMS Philadelphia in the Fall. There will be another international TIMS meeting coming up in the Summer of 1991.

4. WSC Board representative Steve Roberts reported that WSC '89 will be the largest ever, and a large surplus is expected. Roberts fielded questions regarding future fees and locations for WSC, and the

Treasurer's Report

For the period 10/3/89 through 3/14/90 the College had the following transactions at BancOhio National Bank, Columbus, Ohio.

Balance forward:	\$27734.73
Revenues:	
Interest earned	710.93
Dues	3.00
Total revenues	713.93
Disbursements:	
College logo	30.00
Awards	65.75
Newsletters and Publicity	474.83
WSC '90 seed money	2000.00
WSC '89 reception	473.75
Total disbursements	3044.33
Net (revenues - disbursements)	-2330.40
Balance Forward (previous balance + net)	\$25404.33

All funds are in a money market checking account at BancOhio National Bank. In addition to these funds, the College has an account at TMS Headquarters the sum of \$1360.33 (as of 3/14/90), bringing the College's net worth to \$26764.66.

Respectfully submitted,
Bamy L. Nelson, Secretary-Treasurer
March 14, 1990

5. Professor Susumo Morita of Waseda University in Japan reported on simulation activities in Japan. There is a special interest group on simulation of the Operations Research Society of Japan, which has about 50 members and meets bi-monthly.
6. Steve Roberts moved that the TMS/CS reimburse award recipients (Publication and Service) for travel expenses to WSC to receive their award. After a friendly amendment by Lee Schruben, the following motion was passed:
The TMS/CS shall reimburse Service and Publication award winners for reasonable expenses to WSC to receive their awards beginning with WSC '89; such expenses shall be approved by the Executive Committee of the TMS/CS.
7. David Kelton moved that both awards be presented at WSC in the future. The motion passed.
8. Lee Schruben announced that Tom Schriber will replace Bruce Schmeiser on the Distinguished Service Award Committee. Nominations are due to Chairman Robert Sargent by September 1, 1990. The 1989 recipient was Harold Highland.
9. Newsletter Co-Editor Jim Swain reported on the new format for the College Newsletter. He will investigate the cost of having a professional publisher layout, print and mail the Newsletter in the future and will report back to the College.
10. Jim Wilson read the report by Jorge Haddock's committee on attracting women and minorities to simulation. Suggestions included providing help for course development, a paper-thesis competition, and offering our services as speakers. Action will await a motion from the committee.
11. The motion by David Kelton to discontinue the Student Presentation Award, which was tabled at the ORSA/TMS NY business meeting, was reintroduced. It passed.
12. The meeting was adjourned at 6:20 PM.

Respectfully submitted,
Bamy L. Nelson
Secretary-Treasurer

TIMS/College on Simulation presents awards to Dr. Harold Highland and Dr. Luc Devroye

A prolific author and editor, Dr. Highland has written more than 25 books during the past 50 years. Between 1974-81, he edited more than 20 sets of conference proceedings in computer modeling and simulation, as well as computer performance evaluation. In addition to being *Proceedings* Editor of the Winter Simulation Conference for several years, Dr. Highland served as General Chairman of that conference in 1976. He has also been the Editor of several Associations for Computing Machinery publications and is the Founding Editor and Editor-in-Chief of *Computers and Security*.

Dr. Highland maintains affiliations with numerous professional societies, including the Irish Computer Society, the New York Academy of Science, IEEE Computer Society, and American Assn. for the Advancement of Science.

—Lee Schruben and David Goldsman

Prof. Luc Devroye was presented an award at TIMS' College on Simulation's 1989 Winter Simulation Conference. The "1989 Outstanding Publication Award" and a \$500 honorarium went to Prof. Devroye for his book, "Non-Uniform Random Variate Generation," (Springer-Verlag, 1986).

Journal articles, proceedings papers, books, monographs, and technical reports copyrighted in the last four years were eligible for the award. The Awards Committee was chaired by Prof. Stephen D. Roberts (Purdue), and included Prof. Gordon M. Clark (Ohio State University) and Dr. Peter Welch (IBM Corp.).

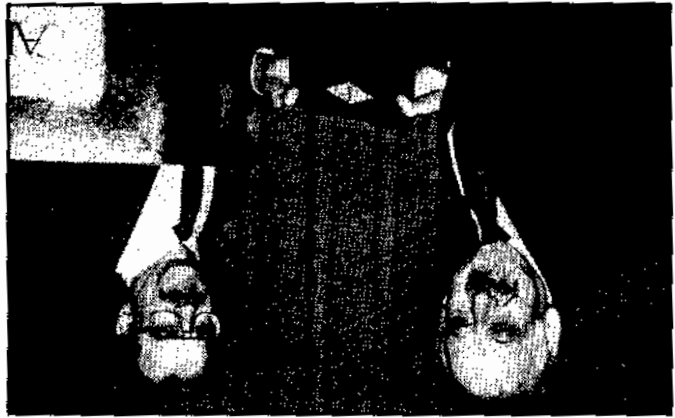
Luc Devroye was born in Tienen, Belgium and received his B.Eng. in Electrical Engineering (with Great Distinction) from the Catholic University of Leuven. He received his Ph.D. (same discipline) from the University of Texas at Austin. Since 1987 he has been a professor in the School of Computer Science at McGill University in Montreal, having risen to

Prof. Devroye has authored five books and over 100 refereed publications. His research interests include the application of probability theory and probabilistic methods in computer science, including expected time analysis of algorithms, random graphs, random pattern recognition, and publications in mathematical statistics focus on nonparametric estimation of densities and regression functions. He is a 1987 recipient of the E.W.R. Steacie Memorial Fellowship, one of Canada's most prestigious academic awards.

—Stephen D. Roberts



Stephen Roberts, right, presents Outstanding Publication Award to Luc Devroye.



Lee Schruben, right, presents Distinguished Service Award to Dr. Harold Highland.

TIMS' College on Simulation presented its "Distinguished Service Award" to Dr. Harold J. Highland at the 1989 Winter Simulation Conference in Washington, D.C. The award, including a \$500 honorarium, is given by the College to recognize exceptional and long-standing service to the simulation community. The Awards Committee was chaired by Prof. Lee Schruben (Cornell University) and included Professors Robert G. Sargent (Syracuse University) and Bruce Schmeiser (Purdue University). Dr. Highland is Distinguished Professor Emeritus of the State University of New York Technical College at Farmingdale. Prior to joining SUNY in 1966, he was both Dean of the Roth Graduate School of Business and Director of the Computer Laboratories at Long Island University. During 1970-71, he was Fulbright Professor of Computer Science and OR at Helsinki University of Technology and at the Medical School of the University of Helsinki. Dr. Highland has taught and conducted seminars at numerous schools and prior to joining the academic community in 1958, he had over 20 years of professional experience.

Announcements Outstanding Simulation Publication Awards for 1990 and 1991

To recognize outstanding contributions to the simulation literature, the College on Simulation annually sponsors an Outstanding Simulation Publication Award. The 1990 Award will be presented by Professor Peter Welch, the outgoing Chairperson of the Awards Committee, at the Opening Session of the 1990 Winter Simulation Conference.

Nominations for the 1991 Outstanding Simulation Publication Award should be sent by December 31, 1990 to the incoming Chairperson of the Awards Committee:

Professor Doug Miller
Department of Operations Research
School of Engineering
George Washington University
Washington, D.C. 20052
(202) 676-7528

The complete set of rules governing the Outstanding Simulation Publication Award appeared in Vol. 9, No. 2 of this *Newsletter* (Fall 1985). In summary, anyone is eligible to win the Award. Journal articles, proceedings, articles, books, and monographs copyrighted in 1987, 1988, and 1989 are eligible for the Award to be presented in 1991. Technical reports, research memoranda, working papers, theses, and dissertations are not eligible.

Nominations may be made by anyone, including the author(s), but they may not be made anonymously. Nominations should include: (a) a copy of the written work including all bibliographical information (in the case of books, the Awards Committee will obtain copies); (b) a short statement suitable for reading at the award ceremony if the work is chosen; and (c) any other information thought relevant by the nominator.

Distinguished Service Award for 1990

To recognize outstanding service contributions to the field of simulation, the College on Simulation annually sponsors an Outstanding Service Award. Nominations for the 1990 Award will be accepted until September 1, 1990.

The Outstanding Service Award Committee consists of Robert Sargent, Thomas Schriber, and Lee Schruben. Send nominations to:

Prof. Robert Sargent
Link Hall

Syracuse University
Syracuse, NY 13244
(315) 423-4348

rsargent@top.cts.syr.edu

Status Report on the Simulation Department of Management Science

For the calendar year 1989, a total of 22 papers were submitted to the Department. At the beginning of last year, 12 papers were in process. During that year, four papers were accepted, 11 papers were rejected, and one paper was withdrawn. Since the first of this year, two new papers have been submitted and four papers have been rejected; thus 16 papers are currently in process. Since the first of this year, nine papers have been sent out for review or re-review, and four papers have been sent back to the authors for revision. We are pleased to announce that Professor Pierre L'Ecuyer of Laval University has agreed to serve as an Associate Editor of the Simulation Department.

The other Associate Editors are Peter Glynn of Stanford University, David Goldsman of Georgia Tech, and Steve Roberts of Purdue University. Reflecting the truly international character of TMS, the editorial staff of the Simulation Department now includes representatives of three different countries—Canada (Glynn, L'Ecuyer), the United States (Goldsman, Roberts), and Texas (Wilson).

—James R. Wilson
Department Editor

Summer Computer Simulation Conference & Exhibition



You are invited to attend North America's premiere computer simulation event, the Summer Computer Simulation Conference and Exhibition, to be held in Calgary, Alberta, Canada, July 16 - 18, 1990. The 1990 Summer Computer Simulation Conference will feature innovative presentations, panel discussions, state-of-the-art reviews, tutorials, and trade show exhibits designed to provide a comprehensive coverage of the field of computer simulation. SCSC'90 is an excellent opportunity to investigate recent advances in the field, view new commercial products, and meet other professionals with similar interests. Share the Calgary experience with your spouse and family - we are just minutes from fabulous 4-season recreation and the conference committee has planned an excellent companions program.

Conference Program

Physical, Chemical, & Engineering Applications
 Marilyn B. Kloss, Mitchell and Gauthier, Associates
 Ragnar Nilsson, Simulation Services

Intelligent Simulation Environments
 Joe K. Ciema, IIT Research Institute

Computer Integrated Manufacturing
 Douglas H. Norrie, University Of Calgary

Energy & Environmental Sciences
 Antonin Setral, Sinteck Consulting Services

Advanced Information Processing
 Eugene J.H. Kerckhoffs, Delft University

Transportation Systems
 Roger Varadarajan, GM Systems Engineering Center

Government, Management, & Social Sciences
 Charles I. Barteld, The American University
 Celik Parkan, University of Calgary

Artificial Intelligence (Introduction and Knowledge Acquisition)
 Mildred Shaw and Bruce Macdonald, University of Calgary

Recent Developments in Security for Distributed Systems
 Harold Podell, Marshall Abrams and Grace Harmon, Computer Educators

Performance Analysis and Logic Verification using Partners
 John Brodie and Janice Snow, Simulogics, Inc.

New Developments in Continuous System Simulation Languages
 Ralph Hunsinger, California State University, Chico

A Tutorial on Parallel Simulation
 Greg Lomow, Jade Simulations

Software Tutorials on Radar & Communications
 Prediction Systems Inc.

Professional Development Tutorials

Configuration Management (HW and SW)
 L.G. Egan, Software Certification Institute

Neural Networks
 Mary Lou Padgett, Auburn University

Discrete Event Simulation of Concurrency
 Dennis Mulcare, Lockheed Aeronautical Systems

Real Time Numerical Networks
 James B. Bradley Consultants

Chaos and Fractals in Engineering Simulations of Nonlinear Processes
 John Michael Smith

Trade Show & Exhibits

The conference trade show promises to be one of the largest vendor exhibitions ever held at a summer simulation meeting. SCSC'90 will be held at the Calgary Convention Center, a world-class facility located in the heart of Canada's oil industry and western financial center. Early exhibitors include: Apollo Computer, Control Data, Sun Microsystems, Jade Simulations, Meiko Scientific, Pulsesearch Consolidated Technology, Pulsone Geophysical, CAE Electronics, AT&T Bell Laboratories, CACI, Boeing Computer Services, Simulation Services International, Tutism Products. Companies interested in exhibiting are invited to contact SCSC '90 c/o Jade Simulations #80, 1833 Crowchild Trail N.W., Calgary, Alberta, Canada, T2M 4S7. Tel: (403) 282-5711, FAX (403) 289-6876.

For registration information, contact:
 Lincoln Fish

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Abstracts of Papers

Thanos N. Avramidis and James R. Wilson, "A Flexible Method for Estimating Inverse Distribution Functions in Simulation Experiments," School of Industrial Engineering, Purdue University, West Lafayette, IN.

Bennett L. Fox and Peter W. Glynn, "Discrete-Time Conversion for Simulating Finite-Horizon Markov Processes," Department of Mathematics, University of Colorado-Denver.

We estimate via simulation the expectation of certain integrals of functionals of continuous-time Markov chains over a finite horizon, fixed or random. By computing conditional expectations given the sequence of states visited (and possibly other information), we reduce variance. This is a discrete-time conversion. We further increase efficiency by combining discrete-time conversion with stratification and splitting.

To generate random variates from an unknown continuous distribution via the inverse transform method, we present a flexible, computationally tractable procedure for estimating the associated inverse distribution function based on sample data. Previously proposed methods for estimating inverse distributions can fail in either the distribution-fitting or variate-generation stages of application. To avoid these difficulties, we have developed procedure IDPF for estimating an Inverse Distribution with a Polynomial Filter. After selecting a baseline or reference distribution by some standard technique, we estimate a polynomial filter for the random-number input by constrained composition of the inverse reference distribution and the polynomial filter that has minimum "distance" from the empirical inverse distribution. The regression constraints ensure that the fitted inverse distribution is nondefective and monotonically nondecreasing.

A specific implementation of IDPF is based on well-known techniques for obtaining reference fits from the Johnson system of distributions. A Monte Carlo study is summarized to demonstrate the effectiveness of the procedure. Compared to the reference fit, IDPF yields significantly closer approximations not only to the empirical inverse distribution but also to the underlying theoretical inverse distribution.

Bennett L. Fox, "Computing Expected Reward up to Absorption and Its Gradient: Deterministic Versus Simulation Methods," Department of Mathematics, University of Colorado-Denver.

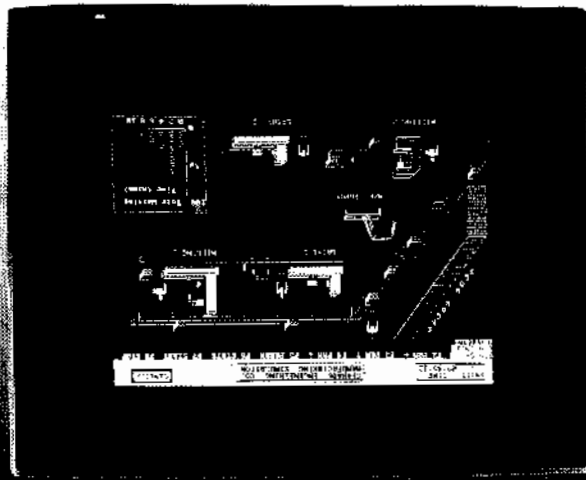
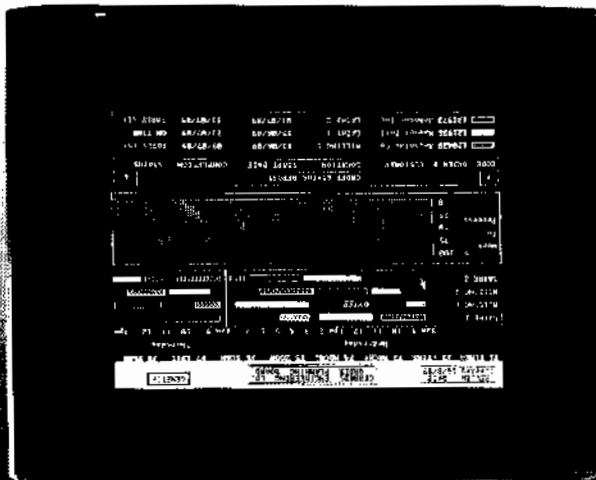
For a Markov chain we compute the expected cumulative reward until absorption as well as its gradient with respect to a (vector) parameter. Successive approximations and simulation are compared. Both approaches fully exploit sparsity of the transition matrix. Our criterion is the computational effort to satisfy a given error tolerance. A link between successive approximations and simulation makes the worst-case work to satisfy a given root-mean-square error tolerance finite. It also generally reduces variance. A one-stage contraction mapping with respect to a weighted maximum norm makes our approach computationally attractive. We justify and quantify the following assertions. If the error tolerance is fixed and the number of states gets large enough, simulate. If the number of states is fixed and the error tolerance gets small enough, use successive approximations. For all intermediate cases, we show how to choose rationally.

Peter W. Glynn and Philip Heidelberger, "Analysis of Parallel, Replicated Simulations under a Completion Time Constraint," IBM T.J. Watson Research Center, Yorktown Heights, NY.

This paper analyzes properties associated with a simple yet effective way to exploit parallel processors in discrete event simulations: averaging the results of multiple, independent replications that are run, in parallel, on multiple processors. We focus on estimating expectations from terminating simulations, or steady-state parameters from regenerative simulations. We assume that there is a CPU time

This paper investigates theoretical properties of a simple method for using parallel processors in discrete event simulations: running independent replications, in parallel, on multiple processors and averaging the results at the end of the runs. Specifically we consider the problem of estimating steady-state parameters from such an experiment. We consider sampling plans in which the replication lengths are given by limits on either simulated or computer time, and in which the beginning portion of each run may be deleted for the purpose of controlling initialization bias. We determine the critical relative growth rates for the number of processors, the length of the replications, and the length of the deletion period that are required in order to produce valid confidence intervals for steady-state parameters. When the replication length is determined by computer time, the straightforward estimator with deletion may not work for a large number of processors. In this case, the deletion is essentially useless due to an additional bias term that arises because the simulated time at the end of a replication is random. In this case, a new estimator can be used to remove this source of bias.

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We show how the Clipper dialect of the popular database language dBASE can be used to support a simulation study by organizing the input for simulation runs, storing the output from the runs, and performing statistical analysis on the stored data. In addition, the language can run the

Paul Goldsman, David Goldsman, James J. Swain, "Using a Database Language in Discrete-Event Simulations," Georgia Institute of Technology, Atlanta, GA.

We also include a power analysis of the new tests. (Schruben, 1982 and Schruben, Singh, and Tierney, 1988). generalizations of some previously published work standardized time series. Our tests can be viewed as natural simulation run, and are based on the asymptotic theory of variance estimators from different parts of a simulation run, and are based on the asymptotic theory of transient mean in a simulation process. These tests compare variance estimators from different parts of a simulation run, and are based on the asymptotic theory of standardized time series. Our tests can be viewed as natural generalizations of some previously published work (Schruben, 1982 and Schruben, Singh, and Tierney, 1988). We also include a power analysis of the new tests.

David Goldsman, Lee Schruben and James J. Swain, "Tests for Transient Means in Simulated Time Series," Georgia Institute of Technology, Atlanta, GA.

In this paper, we consider the problem of estimating a parameter α that can be expressed as a nonlinear function of sample means. We develop a jackknife estimator for α that is appropriate to computational settings in which the total computer budget to be used is constrained. Despite the fact that the jackknifed observations are not i.i.d., we are able to show that our jackknife estimator reduces bias without increasing asymptotic variance. This makes the estimator particularly suitable for small sample applications. Because a special case of this estimator problem is that of estimating a ratio of two means, the results in this paper are pertinent to regenerative steady-state simulations.

Peter W. Glynn and Philip Heidelberger, "Jackknifing under a Budget Constraint," IBM T.J. Watson Research Center, Yorktown Heights, NY.

constraint, t , on each of the processors. Unless the replication lengths are bounded, one must be willing to simulate beyond any fixed, finite time t on at least some processors in order to always obtain a strongly consistent estimator (as the number of processors increases). We therefore consider simulation experiments in which t is viewed as either being a strict constraint, or a guideline, in which case simulation beyond time t is permitted. The statistical properties, including strong laws, central limit theorems, bias expansions and completion time distributions, of a variety of estimators obtainable from such an experiment are derived. We propose an unbiased estimator for a simple mean value. This estimator requires pre-selecting a fraction of the processors. Simulation beyond time t may be required on a pre-selected processor, but only if no replications have yet been completed on that processor.

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Topics in all aspects of discrete event and combined (discrete/continuous) simulation will be covered in sessions following several formats: contributed and invited papers, tutorials, reviews and panel discussions. A special feature is the focus sessions: centering on highly topical problems and issues. Contributions are solicited in the following categories:

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Y. Wardi and J.Q. Hu, "Sufficient Conditions for Strong Consistency of Inflight Perturbation Analysis," School of Electrical Engineering Technical Report, Georgia Institute of Technology, Atlanta, GA.

Jack P.C. Kleijnen, "Regression Metamodels for Simulation with Common Random Numbers: Comparison of Techniques," Technical Report FEW 426, Tilburg University, Tilburg, Netherlands.

simulation itself. We use a small job shop model to illustrate routines for the generation of random variables and events, and for the collection and analysis of statistics.

Multivariate linear regression is important in many fields; in the analysis of simulation results, such a regression (meta) model may apply if common pseudorandom numbers are used. To test the validity of the specified regression model, Rao (1959) generalized the F statistic for lack of fit, whereas Kleijnen (1983) proposed cross-validation using Student's t statistic combined with Bonferroni's inequality. This paper reports on an extensive Monte Carlo experiment designed to compare these two methods. Whereas cross-validation is conservative, Rao's test realizes its nominal α error and has high power. Once the regression model is validated, confidence intervals for the individual

The importance of the misframe times for DSL frame synchronization has often been addressed in designing and using network elements and mediation units. By extending the work of Eu and Rollins, we use Markov chain first

For many financial models implemented in electronic spreadsheets, input data values frequently are random variables because they are actually estimates of unknown quantities. As a result, the bottom-line performance measure of the model is a random variable, and risk is associated with decisions based upon it due to the uncertainty in its value. We describe in detail how to evaluate this risk using simulation in an electronic spreadsheet and illustrate the procedure with an example. Formulas for generating random variates from many common distributions using LOTUS 123 are given, and data analysis considerations are also discussed.

Y. Ward, M. W. McKinnon and R. Shuckie, "On Perturbation Analysis Of Queuing Networks With Finitely Supported Service Time Distributions," School of Electrical Engineering, Georgia Inst. of Technology, Atlanta, GA.

Infiniteesimal perturbation analysis (IPA) has emerged as an efficient tool for estimating the gradient of a function defined on the steady-state of a queueing network. Differentiability of such functions is often assumed, due to difficulties in proving it. In this note we point out that such functions may be nondifferentiable at an infinite set of points, dense in a given interval, for a large class of realistic system-models. Such a phenomenon has not been suspected in the literature on perturbation analysis, and it is largely due to correlation of traffic patterns on the links of a network, and to the presence of atoms in the distributions of their service times. This issue of

regression parameters are computed. The Monte Carlo experiment compares several confidence interval procedures. For simplicity's sake one may stick to Rao's procedure, since it has good coverage probability and acceptable half-length.

Andrew F. Sella and Jerry Banks, "Spreadsheet Risk Analysis Using Simulation," Georgia Institute of Technology, Atlanta, GA.

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Glynn, Peter W. and W. Whit, "The Asymptotic Efficiency of Simulation Estimators," Department of Operations Research, Stanford University.

A decision-theoretic framework is proposed for evaluating the efficiency of simulation estimators. The framework includes the cost of obtaining the estimate as well as the cost of acting based on the estimate. The cost of obtaining the estimate and the estimate itself are represented as realizations of jointly distributed stochastic processes. In this context, the efficiency of a simulation estimator based on a given computational budget is defined as the reciprocal of the risk (the overall expected cost). This framework is appealing philosophically, but it is difficult to apply in practice (e.g., to compare the efficiency of two different estimators) because only rarely can the efficiency associated with a given computational budget be calculated. However, a useful practical framework emerges in a large sample context when we consider the limiting behavior as the computational budget increases. A limit theorem established for this model supports and extends a fairly well-

known efficiency principle, proposed by Hammersley and Handscombe (1964), p. 22: "The efficiency of a Monte Carlo process may be taken as inversely proportional to the product of the sampling variance and the amount of labour expended in obtaining this estimate."

Glynn, Peter W. and W. Whit, "The Asymptotic Validity of Sequential Stopping Rules for Stochastic Simulations," Department of Operations Research, Stanford University.

We establish general conditions for the asymptotic validity of sequential stopping rules to achieve fixed-volume confidence sets for simulation estimators of vector-valued parameters. The asymptotic validity occurs as the prescribed volume of the confidence set approaches zero. There are two requirements: a functional central limit theorem for the estimation process and strong consistency (with probability-one convergence) for the variance of "scaling matrix" estimator. Applications are given for: sample means of i.i.d. random variables and random vectors, nonlinear functions of such sample means, jackknifing, Kiefer-Wolowitz and Robbins-Monro stochastic approximation, and both regenerative and non-regenerative steady-state simulation.

TCS-Sponsored Philadelphia Sessions

TIMS/CS NEWSLETTER

with the number of arcs, we also propose variance-reducing Monte Carlo methods based on bounds which are very efficient for large-scale networks.

Choosing among Competing System Designs Using Monte-Carlo Simulation

Session Chair: Michael R. Taaffe, Department of Industrial and Manufacturing Engineering, The University of Rhode Island, Kingston, RI 02881

Batching Strategies for Multiple Comparison in Steady-State Simulation

Lynne Goldsman and Barry L. Nelson, Department of Industrial & Systems Engineering, The Ohio State University, 1971 Neil Avenue, Columbus, OH 43210

To use multiple-comparison procedures in steady-state simulation analysis at least two issues must be addressed: the possibility of point estimators with unequal variances, and the problem of assigning appropriate degrees of freedom to the point estimators. We propose batching strategies to handle both problems.

Procedures for Selecting the Simulated Population with the Largest Mean

David Goldsman, School of Industrial & Systems Engineering, Georgia Tech, Atlanta, GA 30332

We present procedures for selecting that one of k competing normal populations having the largest mean under various assumptions about the population variances. We then extend the results for use in computer simulations.

A Strategy for Designing Robust Systems Using Discrete-Event Simulation

Rosemary H. Wild, Decision Science Department, University of Hawaii at Manoa, 2404 Maile Way, Honolulu, HI 96822, and Joseph J. Pignatello Jr., Department of Industrial Engineering, The University of Iowa, Iowa City, IA 52242

We propose an experimental-design strategy for designing robust systems using discrete-event simulation. The proposed strategy is motivated by Genichi Taguchi's strategy for improving product and process quality in manufacturing. Our strategy emphasizes designing for robustness upfront rather than relying on post-optimality sensitivity analysis.

Monte-Carlo Post-Experiment Analysis for Choosing among System Designs

Bruce W. Schmeiser and Wei-Ning Yang, School of Industrial

Following are descriptions of three sessions to be sponsored by the TIMS College on Simulation for the Fall 1990 ORSA/TIMS Conference in Philadelphia.

Simulation Methods for Stochastic Networks

Session Chair: Christos Alexopoulos, School of Industrial & Systems Engineering, Georgia Tech, Atlanta, GA 30332

A New Class of Perturbation-Analysis Algorithms for Piecewise-Constant Performance Measures

Yoram Wardi, School of Electrical Engineering, Georgia Tech, Atlanta, GA 30332, Wei-Bo Gong and Christos Cassandras, Department of Electrical and Computer Engineering, University of Massachusetts, Amherst, MA 01003

A class of performance measures, where infinitesimal perturbation analysis (IPA) has not had simple algorithms, involved piecewise-constant sample performance measures. In this talk we present a new, general method of perturbation analysis for such problems. The method is flexible and yields simple algorithms. The proposed technique will be demonstrated for the zero-finding probability in a GI/G/1 queue, and for the threshold-delay probability in a serial network.

Fast Simulation of Dependability Models with General Failure, Repair and Maintenance Processes

Victor Nicola, Phillip Heidelberger, and Ambuj Goyal, IBM Research Division, P.O. Box 704, Yorktown Heights, NY 10598, and Marvin K. Nakayama, Department of Operations Research, Stanford University, Stanford, CA 94305

The evaluations of dependability measures for repairable systems with general failure and maintenance processes are hard problems. Since the system failure is typically a rare event, we present a simulation method based on importance sampling which results in large reduction in run lengths. We illustrate the effectiveness of the proposed technique for a large computing system.

Shortest-Path Problems in Stochastic Networks with Dependent Arc Lengths

Christos Alexopoulos, School of Industrial & Systems Engineering, Georgia Tech, Atlanta, GA 30332

We present methods for evaluating probability distributions related to the shortest path length in networks whose arcs have random dependent lengths. Since the time requirements for exact methods can increase exponentially

this talk, we share our results, as well as our experiences in applying control variates for a non-technical client.

A Flexible Method for Estimating Inverse Distribution Functions in Simulation Experiments

Athanasios Avramidis and James R. Wilson, School of Industrial Engineering, Purdue University, West Lafayette, IN 47907

To generate random variates from an unknown continuous distribution via the inverse-transform method, we present a flexible, computationally tractable procedure for estimating the associated inverse distribution function based on sample data. We present the results of an extensive Monte Carlo study to demonstrate the effectiveness of the method.

Estimating Acceptance-Sampling Plans for Dependent Production Processes

Barry L. Nelson, Department of Industrial and Systems Engineering, The Ohio State University, 1971 Neil Avenue, Columbus, OH 43210

When acceptance sampling is used to judge the quality of an ongoing production process, the quality of successive items may exhibit statistical dependence that is not accounted for in standard acceptance-sampling plans. This talk presents an efficient method for estimating single-sampling attributes plans for any production process model that can be simulated.

Engineering, Purdue University, West Lafayette, IN 47907

We consider statistical (including stochastic-simulation) experiments that compare system designs. Given various assumptions and parameters, existing methodologies (e.g., ranking-and-selection or multiple-comparisons-with-the-best) calculate constants (e.g., sample sizes or quantiles) necessary to guarantee some minimal nominal performance (e.g., probability of correct selection or overall confidence). We discuss Monte Carlo methods for a practitioner to estimate actual performance.

Statistical Issues in Simulation

Session Chair: Nabil R. Adam, Graduate School of Management, Rutgers University, Newark, NJ 07102

An Application of Variance-Reduction Techniques to a Naval-Gunfire Simulation Model

Keobom Kang, Michael P. Bailey, Alexander Callahan, and Marcelo Bartoli, Department of Operations Research, Naval Postgraduate School, Monterey, CA 93943-5000

In this study, we examine the effects of ammunition component reliability on the performance of a naval gun-fire support system. Due to the large number of possible component configurations, we were motivated to explore variance reduction through the use of control variates. In



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Event Calendar

mation, contact Philippe Geril, University of Ghent, Coupure Links 653, B-9000 Ghent, Belgium. Electronic Mail: geril@bgerug51.bitnet or scsi@bgerug51.bitnet. Phone: 0032,91.236961, ext. 233.

12, 1990, New Orleans, LA. Contact Randall P. Sadov-ski, Systems Modeling Corporation, 504 Beaver Street, Sewickley, PA, 15143 (412-741-3727) or Richard E. Nance, Computer Science Dept., Virginia Tech, Blacksburg, VA 24061, Phone: (703)-961-6144.

1991
TMS/ORSA Joint National Meeting, May 12-15, Opryland Hotel, Nashville, TN. For further information, contact Michael Beasley, Dover Electric Corp., P.O. Box 6400, Home Lake, MI 38637.

TMS/ORSA Joint National Meeting, November 3-6, Hilton Hotel, Anaheim, CA. For further information, contact Carlton Scott, Graduate School of Management, University of California, Irvine, CA 92717.

1992
TMS/ORSA Joint National Meeting, April 26-29, Marriott World Center, Orlando, FL. For further information, contact Bill Swart, Industrial Engineering Dept., University of Central Florida, Orlando, FL.

TMS/ORSA Joint National Meeting, May 7-9, 1990, Caesars Palace, Las Vegas, NV. For further information, contact Asim Roy, Dept. of Decision and Information Systems, College of Business, Arizona State University, Tempe AZ 85287, Phone: (602) 965-6324.

European Simulation Multiconference, June 10-13, 1990, Nuremberg, West Germany. For further information, contact Philippe Geril, University of Ghent, Coupure Links 653, B-9000 Ghent, Belgium. Electronic Mail: geril@bgerug51.bitnet or scsi@bgerug51.bitnet. Phone: 0032,91.236961, ext. 233.

1990 Summer Computer Simulation Conference, July 16-18, 1990, Skyline Hotel, Calgary, Alberta, Canada. For further information, contact The Society for Computer Simulation, P.O. Box 17900, San Diego, CA 92117. Phone: (619) 277-3888.

TMS/ORSA Joint National Meeting, October 28-31, 1990, Wyndham Hotel, Philadelphia, PA. For further information, contact Benjamin Lev, Dept. of Management, 100 Institute Road, Worcester Polytechnic Institute, Worcester, MA 01609. Phone: (508) 831-5548.

European Simulation Symposium, November 8-10, 1990, Het Pand, Ghent, Belgium. For further information, contact

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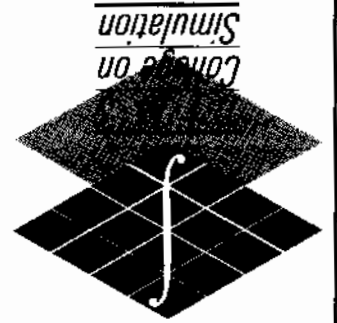
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 Volume 14, Number 1, Spring 1990