

DECISION ANALYSIS NEWSLETTER

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Editor' Note

Just a reminder that we are eager to publish abstracts of all papers in the area of Decision Analysis, broadly conceived. The only requirements for our publishing an abstract of your work are:

1) That the paper itself not have appeared in print yet; 2) that it is available for distribution upon request; and 3) that the abstract not exceed 200 words by much.

If there is a charge, please so indicate when you send your complete paper to the editor:

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Please phone or write in any changes in your activities or employment that could be of interest to our membership.

Please Note: (1) Inform the ORSA business office at Mount Royal and Guilford Avenues, Baltimore, MD 21202 of address change; we get our mailing labels from them! Thanks!
(2) To be included on the mailing list, you should join the Special Interest Group on Decision Analysis: send letter to ORSA office and \$3 (\$5) for a ORSA (non)member.

Inside

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Orlando Meeting

Kevin McCardle and Bob Nau, both at Fuqua School of Business, Duke University, Durham, NC 27706, are organizing the Decision Analysis sessions for the Orlando TIMS/ORSA Meeting [April 26-29, 1992]. Anyone interested in organizing a SIG-Sponsored session for this meeting should contact Kevin or Bob almost instantly!

Congratulations To:

Oleg I. Larichev--Rex Brown reports that Professor Larichev, a founding member of IIASA, has been elected a correspondent-member of the USSR Academy of Sciences. He currently serves as Head of the Department of Decision Sciences, Institute for System Studies of the USSR Academy of Sciences in Moscow.

Rick G. Schwartz--Appointed a Principal in Applied Decision Analysis, Inc., 3000 Sand Hill Rd., Menlo Park, CA 94025.

Martin Weber--Who has been appointed Chaired Professor and Director, Lehrstuhl für Allgemeine Betriebswirtschaftslehre und Entscheidungsforschung, University of Kiel, Olshausenstrasse 40, 2300 Kiel, Germany.

Brief Bios of Council Nominees

William E. Balson is a Principal of Decision Focus, Inc. Major projects with which he has been involved as a consultant include research and development options analyses, environmental impacts, political risk analyses and regulatory uncertainty. He has supervised the development of DFI's influence-diagram software, InDia, and has lectured extensively on Decision Analysis. Dr. Balson earned the Bachelor of Industrial Engineering degree from Georgia Tech in 1971, and the M.S. and Ph.D. degrees in Engineering - Economic Systems from Stanford in 1977 and 1982 respectively.

Harvey J. Gold is Professor of Statistics and Biomathematics and is a member of the interdisciplinary Operations Research faculty at North Carolina State University. He teaches a graduate level course titled "Decision Analytic Modeling", which combines theory with application. His research focuses on the use of the decision analytic paradigm as a basis for combining uncertain and incomplete information from diverse sources, including expert judgment, frequency based data, and system simulation. Application is to decisions and development of decision rules for classes of decisions involving systems with multiple uncertainties and time dependent dynamics. Areas of application include agricultural pest control; toxic waste remediation; choosing between alternative manufacturing technologies. Publications have been primarily in applications oriented journals, such as *Agricultural Systems*, *Ecological Modeling*, *Plant Disease Epidemiology*, and *Environmental Entomology*.

Donald L. Keefer is Associate Professor of Management Science in the Department of Decision and Information Systems, College of Business, Arizona State University. He holds a B.S. from Carnegie-Mellon and an M.S. from Stanford in Mechanical Engineering and an M.S. and Ph.D. from Michigan in Industrial and Operations Engineering (1976). He has had fourteen years of industrial experience with Gulf Oil and one year with Chevron, most of it within Gulf's management sciences group where he specialized in decision analysis applications. He is conducting research on models for resource allocation problems involving major uncertainties and on approximation methods in probabilistic modeling. His papers have appeared in a variety of OR/MS and engineering journals including *Management Science* and *Operations Research*.

Kathryn Blackmond Laskey is a Research Associate Professor with the School of Information Technology and Engineering at George Mason University. Her primary research focus is the application of decision theoretic approaches to automated reasoning under uncertainty. Other research interests include design and implementation of computerized decision support systems, development of theoretically justified decision support approaches that take account of human information processing capabilities and theoretical and applied research in Bayesian and other theories of inference. Prior to joining George Mason University, Dr. Laskey was a Principal Scientist with Decision Science Consortium, Inc. She received her Ph.D. degree in Statistics and Public Affairs from Carnegie Mellon University in 1985.

PAPERS RECEIVED

Please request copies directly from the author, not the Newsletter Editor

From **P. George Benson**, Carlson School of Management, University of Minnesota, 271 19th Ave., South, Minneapolis, MN 55455, and **Kathleen M. Whitcomb**, Department of Management Science, University of South Carolina, Columbia, SC 29208:

The Effectiveness of Imprecise Probability Forecasts

In this paper we investigate the feasibility of algorithmically deriving precise probability forecasts from imprecise forecasts. We provide an empirical evaluation of precise probabilities that have been derived from two types of imprecise probability forecasts: probability intervals and probability intervals with second-order probability distributions. The minimum cross-entropy (MCE) principle is applied to the former to derive precise (i.e., additive) probabilities; expectation (EX) is used to derive precise probabilities in the latter case. Probability intervals that were constructed without second-order probabilities tended to be narrower than and contained in those that were amplified by second-order probabilities. Evidence that this narrowness is due to motivational bias is presented. Analysis of forecasters' mean Probability Scores for the derived precise probabilities indicates that it is possible to derive precise forecasts whose external correspondence is as good as directly assessed precise probability forecasts. The forecasts of the EX methods, however, are more like the directly assessed precise forecasts than those of the MCE method.

From **Colin F. Camerer** and **Teck-Hua Ho**, Department of Decision Sciences, The Wharton School, 1300 Steinberg Hall-Dietrich Hall, University of Pennsylvania, Philadelphia, PA 19104-6366:

Nonlinear Weighting of Probabilities and Violations of the Betweenness Axiom

Betweenness is a weakened form of the independence axiom, which states that a probability mixture of two gambles should lie between them in preference. Betweenness is widely used in generalizations of expected utility and applications to game theory and macroeconomics. Experimental studies show that violations of betweenness are widespread and systematic. In new experiments, we found that violations are not due to intransitivity, and violations are much less frequent when probability mixtures are presented in compound form. In a new analysis, we show that betweenness violations can be largely explained by nonlinear weighting of probabilities. These data suggest that the betweenness axiom is a poor replacement for the independence axiom on empirical grounds, and a form of expected utility in which probabilities are weighted nonlinearly is a much better replacement than theories based on betweenness.

From **Deepak K. Datta** and **P.-L. Yu**, School of Business, Summerfield Hall, University of Kansas, Lawrence, KS 66045-2003 [address requests to Professor Datta]:

Corporate Acquisitions: The Merging of Habitual Domains

This paper illustrates how an understanding of the concepts and issues associated with organizational and individual habitual domains can significantly improve the analysis of acquisition alternatives. Specifically, we stress the importance of a more comprehensive analysis of acquisitions,

one that goes beyond an examination of just financial and economic issues and recognizes the importance of the human side of acquisitions. Consideration of the human aspect is important not only in pre-acquisition analysis but also in how the acquisition is to be eventually implemented. This paper emphasizes issues related to the habitual domains of the two organizations, the fit therein, and the potential costs associated with their assimilation. Based on the same, we develop a framework which can be used for a more comprehensive and effective analysis of acquisition opportunities.

From Peter C. Fishburn, Rm. 2C-354, AT&T Bell Laboratories, 600 Mountain Road, Murray Hill, NJ 07974-2070:

Induced Binary Probabilities: A Status Report

This report summarizes research on the problem of characterizing all systems of binary probabilities on a finite set that are induced by probability distributions over the family of linear orders of the set. We begin with essential definitions, remarks about the two largely separate literatures on the problem, and historical notes. The rest of the paper focuses on systems of inequalities that define the facets of the space of all induced binary probability systems, i.e., facets of the linear ordering polytope.

Multiattribute Signed Orders

A self-reflecting signed order is a preference relation that compares relative likes and dislikes for items in a set X by jointly ordering X and a disjoint copy of X . If you would like Jones but not Smith appointed to a committee, and also think it more important to exclude Smith than include Jones, your self-reflecting signed order records all this information. We review basic representational theory for signed orders, then examine them when X is multiattributed. Axioms for additive measurement of multiattribute self-reflecting signed orders are given for several X structures.

Utility as an Additive Set Function

Foundations for additive models of subset evaluation are stated by axioms for a preference relation on a family S of subsets of X that cover X . The axiomatizations include cases in which S is arbitrary, S contains only finite subsets of X , and S is the set of all subsets of X . Expected utility with subsets as outcomes is also considered.

From Peter C. Fishburn [address above] and Irving H. LaValle [see p.1]:

Multiattribute Expected Utility Without the Archimedean Axiom

Two prominent themes in expected utility theory that were developed many years ago are non-Archimedean expected utility and independence conditions in multiattribute real-valued expected utility. This paper integrates these themes in an investigation of independence conditions for multiattribute vector-valued expected utility. The dimensionality of the utility space need bear no relationship to the number of attributes. The multiattribute independence conditions examined include value independence, utility independence, generalized utility independence, and two-factor mutual utility independence. Attribute decompositions of components of utility vectors implied by some of the conditions are natural generalizations of forms that arise in the real-valued setting.

From **Ronald M. Harstad**, Department of Economics, Virginia Commonwealth University, Richmond, VA 23284-4000, and **Michael H. Rothkopf**, RUTCOR and School of Business, Rutgers University, New Brunswick, NJ 08903-5062:

Models of Information Flows in English Auctions
[Rutgers Research Report #6-91]

Analyses of English auctions have been based on the model of Milgrom and Weber [1982]. The expected-revenue supremacy they find for English auctions is shown to depend critically upon a seemingly artificial restriction of bidders' strategy sets, which forces bidders to reveal information they would rather conceal. When an enriched strategy set incorporates realistic opportunities for concealing information, the expected price is not as high and the auction is less revealing. If information can be transmitted to the seller in full privacy and confidence, expected revenue is equivalent to that of a second-price sealed-bid auction, and may be further reduced by suspicions of bid-running or backups. We also analyze an intermediate case, in which bidders' chances of successfully concealing information decrease as the auction progresses.

From **Charles M. Harvey**, College of Business Administration, University of Houston, Houston, TX 77204-6282:

A Slow-Discounting Model for Energy Conservation

Public benefits in the distant future receive very little importance when a policy analysis uses present value discounting to weigh future benefits against present costs. This happens because with a constant discount rate the weights assigned to future events are a geometrically decreasing sequence. We describe the application to an energy conservation choice of an alternative model that allows these weights to decrease more slowly and thus to accord greater importance to the distant future. The U.S. Department of Energy is interested in whether federally funded residential housing should be required to meet a proposed performance standard for energy conservation. A previous analysis using present value discounting had shown a ratio of future benefits to initial costs of 2.3 to 1. By contrast, the analysis reported here shows a benefit to cost ratio of 30 to 1. This analysis includes a slow discounting of future benefits, an accounting of the social costs of energy usage, and new information on energy costs and the longevity of houses.

From **Donald L. Keefer** and **William A. Verdini**, Department of Decision and Information Systems, Arizona State University, Tempe, AZ 85287-4206:

**Comparison of Simple Approximations in Estimating Means and Variances
of Beta Distributions: Detailed Results**

This report documents the performance of a variety of simple general-purpose approximations in calculating means and variances for a test set of beta distributions originally used by Keefer and Bodily. It provides a complete description of numerical work that has previously only been summarized in the literature, thereby facilitating detailed comparisons of popular methods that differ widely in performance. In addition, a number of more recent approximations are compared over these test distributions for the first time. Some of these new methods perform extremely well, while others perform very poorly. This report should be of interest to those employing simple approximations for continuous judgmental probability distributions in decision and risk analysis, in probabilistic PERT activity time analyses, in engineering-economic analyses, and in other applications involving parameter estimation.

From **Craig W. Kirkwood**, Department of Decision and Information Systems, Arizona State University, Tempe, AZ 85287-4206:

Formulating and Solving Large Decision Tree Models
[Technical Report DIS 90/91-7]

An algebraic approach is presented to formulating and solving large decision tree models, the approach uses algebraic functions to determine branch probabilities and branch values for decision tree nodes. This simplifies formulation of large decision tree models, and it is straightforward to program a general-purpose computer solver for models formulated in this manner. The performance of such a solver is reviewed for an application with an decision tree that has 157,464 endpoints.

ADAM: An Algebraic Decision Analysis Modeling System
[Technical Report DIS 90/91-6]

The Algebraic Decision Analysis Modeling system (ADAM) assists with analyzing large decision tree models. It runs under MS/PC-DOS Version 2 or later. Some knowledge of the Pascal programming language is required, and the user must have a Turbo Pascal compiler, version 4.0 or later. ADAM is a powerful tool for formulating and solving large decision tree models, but it was designed primarily as a research prototype to test the practical applicability of algebraic decision tree formulation methods. Hence, the user needs some understanding of program editing and the preparation of an executable program file using a compiler. Complete source code is included for the ADAM system. (Specify either 5.25" or 3.5" diskette.) A single user license for ADAM is \$25.00, and this includes one copy of the software and one bound copy of the manual. An instructional license is \$50.00. Please make check payable to "DIS Department Gifts and Grants Account."

From **Vahid Lofti**, School of Management, University of Michigan-Flint, Flint, MI 48502, **Theodor J. Stewart**, Department of Mathematical Statistics, University of Cape Town, Cape Town, South Africa, and **Stanley Zionts**, Department of Management Science and Systems, School of Management, State University of New York at Buffalo, Buffalo, NY 14260:

An Aspiration-Level Interactive Model for Multiple Criteria Decision Making

A simple, eclectic approach for solving discrete alternative multiple criteria decision problems is presented. It is based on the concept of the level of aspiration, and draws on ideas of various researchers. It assumes that the user has a set of alternatives with each alternative having a score on each of a number of objectives or measures of performance. The user determines his levels of aspiration for different objectives in an interactive personal computer environment in which he is given considerable feedback as to the degree of feasibility of each level of aspiration as well as the degree of feasibility with respect to all levels of aspiration as a whole. The closest nondominated solution to the solution specified by the levels of aspiration is provided, as are other useful outputs. We develop a method based on these ideas that is easy to use and easy to understand. We have implemented the approach on a personal computer (i.e., an IBM PC or compatible with 512K RAM). We describe an experimental application in which 49 students in an M. B. A. program used the method to solve two discrete alternative multiple criteria decision problems. [There is a \$10.00 charge for the computer package, consisting of the diskette and user's manual.]

From Robert F. Nau, Fuqua School of Business, Duke University, Durham, NC 27706:

Coherent Decision Analysis with Inseparable Probabilities and Utilities

De Finetti's operational definition of subjective probability is extended to give an integrated treatment of probability and utility in the context of a finite decision analysis problem. It is shown that utilities as well as probabilities can be elicited via the acceptance of small monetary gambles when the subject is a subjective-expected-utility maximizer with nonlinear, state-dependent, and/or multi-attribute utility. The principle of coherence (no arbitrage) requires the subject to act *as if* he is maximizing expected utility in accordance with the revealed values of his probabilities and utilities. This constitutes a formalization of rational decision-making in a "small world," in which transactions involving money are the primitive language through which beliefs and values are communicated. Probability and utility cannot be uniquely separated by such transactional measurements. However, it is argued that this inseparability is not problematic either for statistical or economic theory.

From Rüdiger von Nitsch, RWTH Aachen, Templergraben 64, 5100 Aachen, Germany, and Martin Weber, Lehrstuhl für Allgemeine Betriebswirtschaftslehre und Entscheidungsforschung, University of Kiel, Olshausenstrasse 40, 2300 Kiel, Germany [address requests to Professor Weber]:

The Effect of Attribute Ranges on Weights in Multiattribute Utility Measurements.

This study investigates how the weight of an attribute in multiattribute utility measurement is related to its range. It is shown that multiattribute utility theory (MAUT) requires a specific relation between range and weight. Using an empirical investigation, we found that subjects do not adjust their judgments properly if the range is varied. For the two methods tested, the adjustment is smaller than required by theory. The bias due to changing ranges we found to be smaller for a conjoint procedure than for the direct ratio method. Weights based on an intuitive range were not found to be superior to those elicited using different ranges.

From Michael H. Rothkopf, RUTCOR, Rutgers University, Box 5062, New Brunswick, NJ 08903-5062, and Ronald M. Harstad, Department of Economics, Virginia Commonwealth University, Richmond, VA 23284-4000:

On the Role of Discrete Bid Levels in Oral Auctions [RUTCOR Research Report #5-91]

Bids in oral auctions are restricted to discrete levels. This paper both examines the choice of levels at which bids will be allowed and also presents a simple model of the role of the discrete levels in bidding strategy. We consider two different distributions of bidders' values, identifying cases in which revenue is maximized by increasing intervals, by constant intervals, and by decreasing intervals. Moreover, conditions under which the choice of bid levels that maximizes bid taker revenue also maximizes economic efficiency are developed. We present a model of the economic tradeoff between auction duration and step size. We consider the previously undiscussed issue of when economically motivated bidders should skip bid levels and when they should merely make minimum advances and develop a model in which it is equilibrium behavior always to make the minimum allowed advance.

From **Prakash P. Shenoy**, School of Business, Summerfield Hall, University of Kansas, Lawrence, KS 66045-2003:

Valuation-Based Systems for Bayesian Decision Analysis

This paper proposes a new method for representing and solving Bayesian decision problems. The representation is called a valuation network and has some similarities to influence diagrams. However, unlike influence diagrams which emphasize conditional independence, valuation networks emphasize factorization of the joint probability distribution and the joint utility function. The solution method is a hybrid of the local computation method for computation of marginals of joint probability distributions and the local computation method for discrete optimization problems. We represent and solve one simple example, the oil wildcatter's problem, in complete detail. We briefly compare our representation and solution methods to those of influence diagrams.

From **Yong Shi** and **Po-Lung Yu**, School of Business, Summerfield Hall, University of Kansas, Lawrence, KS 66045-2003 [address requests to Professor Shi]:

Selecting Optimal Linear Production Systems in Multiple Criteria Environments

A production system in given environments is an input-output system that transforms a set of resources, *inputs*, into a set of products or services, *outputs*. (see Starr [1] and buffa [2]) In the literature on production/operations management there are two basic approaches to study production systems. One is known as the *general system* and another is known as the *activity approach*. The general system approach is to formulate and solve the general system models that contain a number of subsystems (see Alcalay and Buffa [3] and Reisman and buffa [4]). In these models the transformation process is represented by a series of information balance equations among subsystems, in which non-linear functions may be involved. The activity approach is to treat production systems as "linear transformation processes" and to identify the best group of activities by using linear programming (see Koopmans [5], Charnes and Cooper [6] and Churchman [7]). However, the activity approach does not handle the case where production systems involve multiple criteria and multiple levels of resource availability. In addition, it does not prepare the related contingency plans for optimal production systems to flexibly cope with changes of decision parameters, such as criterion coefficients and resource available levels. In this paper we extend and generalize the activity approach to formulate problems of selecting linear production systems. Using the multiple-criteria and multiple-constraint level (MC²) simplex method derived by Seiford and Yu [8], we propose an effective method to systematically identify optimal linear production systems and prepare their corresponding contingency plans for various decision situations. Optimal production systems and their corresponding set of contingency plans can be used with flexibility to deal with the dynamic change of decision parameters.

From **Po-L. Yu** [address above] and **Dazhi Zhang**, Hagan School of Business, Machine Intelligence Institute, Iona College, New Rochelle, NY 10801 [address requests to Professor Zhang]:

A Foundation for Competence Set Analysis

For each decision problem, there is a competence set consisting of knowledge, information and skills for its effective solution. How the decision maker acquires and expands his/her competence set plays a key role in the process and quality of decision making. This paper provides a mathematical foundation for studying competence sets, their expansion processes and stability. Time and cost functions for expansion, reachable domains, effective expansion using minimal spanning trees,

random set decomposition of competence sets, marginal analysis, connectivity, metrization and stability of competence sets are some key concepts introduced.

Optimal Expansions of Competence Sets and Decision Supports

When the competence set is discrete and finite, its elements can be represented by nodes of a graph. An expansion process of the competence set from the existent skill set to the desired true competence set can be represented by a tree construction. Minimal spanning tree becomes an effective tool for studying the optimal expansion process. The following are addressed in this paper: (i) costs of expansion and reachable domains, (ii) minimal spanning tree, lexicographical optimality, next-best method, and optimal expansion processes, (iii) decision support for expanding competence set.

From **Dazhi Zhang** [address above], **Po-L. Yu** [address above], and **Pei-Zhuang Wang**, Department of Mathematics, Beijing Normal University, Beijing, China [address requests to Professor Zhang]:

State-Dependent Weights in Multicriteria Value Functions

In this paper, the concept of state-dependent weights is extensively studied, which offers the flexibility to approximate the changing weights of the decision maker. The relationship between state-dependent weights and value functions is briefly discussed.

NEWS RELEASE

Newtech Expert Choice: A Decision Support Software System for the Adoption of New Technology

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