

# 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.

## A Message From The Chair

By Robert L. Winkler. Spending the 1990-91 academic year at INSEAD provides me with a perfect opportunity to reflect on the field and to think about new research topics. In that  
(Cont'd. page 2)

## Shachter Wins First Decision Analysis Publication Award

At the Philadelphia meeting, Bob Winkler presented the first annual Decision Analysis Publication Award to Ross D. Shachter of Stanford University for his paper, "Probabilistic inference and influence diagrams," which appeared in *Operations Research*, vol. 36 (1988), pp. 589-605. All works published in 1988 were eligible to be nominated for the 1990 award. Shachter received a plaque and a check for \$750; the abstract of his fine paper is as follows:  
(cont'd. page 2)

## David Heckerman Wins Fifth Annual Decision Analysis Student Paper Competition

By Dennis M. Buede. Dr. David Heckerman won the fifth annual ORSA Decision Analysis Special Interest Group's Student Paper Competition with his paper, "Probabilistic Similarity Networks". Dr. Heckerman received his Ph.D. in Medical Information Sciences at Stanford University. His dissertation advisor was Professor Ron Howard.

Dr. Dennis Buede was the Chair of the 1990 Student Paper Competition. The other judges for the competition were Professor Hutton Barron, Professor Frederick Buoni, Professor Charles Harvey, Professor Benjamin Hobbs, Dr. Bruce Judd, Dr. Anne Martin, and Professor Allan Murphy. A total of eleven papers were received for this year's competition and the quality of the papers was very high.  
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## Inside

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### Chairperson, cont'd.

regard, I am pleased to note that the SIG's two most recent "competitions" indicate that the field is very active, with some exciting work being done on a variety of topics. Congratulations to David Heckerman and Ross Shachter for winning the Student Paper Competition and the Publication Award, respectively. Dennis Buede, who ran the Student Paper Competition, reports that the field was exceptionally strong this year in terms of both quality and quantity. This certainly bodes well for the future of the field. As for the Publication Award, the nominations were not high in number but were of top quality; some judges thought all of the nominees were worthy of the award and found it difficult to rank them. David and Ross should be proud of rising to the top amidst tough competition.

As usual, the presentation of awards means that it is time to start thinking about next year's awards. Please look at the calls for submissions of student papers and nominations for the 1991 Publication Award (covering 1989 publications) elsewhere in this Newsletter. In particular, I hope that greater awareness of the Publication Award will lead to greater participation in the form of a larger volume of nominations (perhaps with considerable overlap). To provide a bit of extra incentive for the Student Paper Competition, the SIG Council has voted to provide a \$500 honorarium, beginning with the 1991 award. The Publication Award already includes a \$750 honorarium. But the real honor, of course, which remains long after the money is spent, is the recognition by one's peers.

The SIG's activities rely on the efforts of a lot of people who contribute their time. Thanks are in order to Dennis Buede for running the Student Paper Competition (and for agreeing to do so for one more year) and to the judges for the two competitions. And let's not forget Colin Camerer and Howard Kunreuther, who organized the SIG's excellent track of sessions in Philadelphia.

Finally, let me conclude by trying to borrow some of *your* time. In my Ramsey Medal presentation at Philadelphia, I ventured (cont'd. page 3)

### Shachter, cont'd.

"An influence diagram is a network representation for probabilistic and decision analysis models. The nodes correspond to variables which can be constants, uncertain quantities, decisions, or objectives. The arcs reveal the probabilistic dependence of the uncertain quantities and the information available at the time of the decisions. The detailed data about the variables are stored within the nodes, so the diagram graph is compact and focuses attention on the relationships among the variables. Influence diagrams are effective communication tools and recent developments also allow them to be used for analysis. We develop algorithms to address questions of inference within a probabilistic model represented as an influence diagram. We use the conditional independence implied by the diagram's structure to determine the information needed to solve a given problem. When there is enough information we can solve it, exploiting that conditional independence. These same results are applied to problems of decision analysis. This methodology allows the construction of computer tools to maintain and evaluate complex models."

### David Heckerman, cont'd.

The winner was announced at the ORSA/TIMS meeting in Philadelphia, October 29, 1990. Inquiries about the competition may be addressed to Dr. Dennis M. Buede, Decision Logistics, 2139 Golf Course Drive, Reston, VA 22091 (703-860-3678).

### Wakker Back at Nijmegen

Peter P. Wakker has returned to Nijmegen after spending a year in the U.S., largely at Duke. His address is: University of Nijmegen (NICI), P.O. Box 9104, 6500 HE Nijmegen, The Netherlands. Phone: 31-80-512651 (office), 31-80-512650 (Secretary); e mail: u212761@HNUKUN11; fax: 31-80-564606.

Chairperson, cont'd.

some opinions regarding future directions for the field and "hot topics and challenges for the '90s." Given my work on the combination of information from multiple experts, it should not be surprising that I am taking advantage of this forum to attempt to gather information from a wide variety of people interested in decision analysis. In particular, I am soliciting thoughts from readers of the Newsletter on these questions relating to the field of decision analysis (broadly defined):

1. What do you view as the top 5-10 topics/challenges for the '90s in decision analysis?
2. How do you think decision analysis will have changed (in terms of practice and in terms of research directions) a decade from now as we enter the 21st century?

Please send your thoughts to me at INSEAD (INSEAD, Bd. de Constance, 77305 Fontainebleau Cedex, FRANCE; e-mail -- winkler@FREIBA51; fax 33-1-60-74-42-42). If you prefer to use my U. S. address, (Fuqua School of Business, Duke University, Durham, NC 27706; fax 919-684-2818), mail is being forwarded regularly. I encourage you to write soon before this request is forgotten. Thanks for your help, and best wishes to all for the holiday season!

Call For Papers - Special Issue of Interfaces:  
"The Practice of Decision and Risk Analysis"

Decision analysis has come of age as a methodology and practice for decision making under uncertainty. It has advised policy at the highest levels of business and government, and aided individuals in their private decisions. Risk analysis, a companion methodology, has been used on countless project evaluations. This special issue will publish papers describing important applications, tutorials on state-of-the-art methods, updates on consulting practice and management training, essays on the contributions and limitations of decision and risk analysis, and related topics. Of particular interest are papers on international applications, practice, and opportunities.

Please submit papers by February 1, 1991 in *Interfaces* format. All papers will be reviewed using *Interfaces* standards and the applications will be verified. Please submit five copies of each paper and address inquiries to the special issue editor:

Samuel E. Bodily, Darden Graduate Business School, University of Virginia, Box 6550, Charlottesville, VA 22906, Telephone: 804-924-4813, fax: 804-924-4859.

## PAPERS RECEIVED

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

From **Katrin Borchering**, Institut für Psychologie, Technische Hochschule Darmstadt, D-6100 Darmstadt, FRG; **Thomas Eppel**, Krannert Graduate School of Management, Purdue University, Lafayette, IN 47907; and **Detlof von Winterfeldt**, Institute of Safety and Systems Management, University of Southern California, Los Angeles, CA 90089;

### Comparison of Weighting Judgments in Multiattribute Utility Measurement

This paper compares four weighting methods in multiattribute utility measurement: the ratio method, the swing weighting method, the tradeoff method and the pricing out method. 200 subjects used these methods to weight attributes for evaluating nuclear waste repository sites in the United

States. The weighting methods were compared with respect to their internal consistency, convergent validity, and external validity. Internal consistency was measured by the degree to which ordinal and cardinal or ratio responses agreed within the same weighting method. Convergent validity was measured by the degree of agreement between the weights elicited with different methods. External validity was determined by the degree to which weights elicited in this experiment agreed with weights that were elicited with managers of the Department of Energy. In terms of internal consistency, the tradeoff method fared worst. In terms of convergent validity, the pricing out method turned out to be an outlier. In terms of external validity, the pricing out method showed the best results. While the ratio and swing methods are quite consistent and show a fair amount of convergent validity, their external validity problems cast severe doubt on their usefulness. The main recommendation for applications is to improve the internal consistency of the tradeoff method by careful interactive elicitation and to use it in conjunction with the pricing out method to enhance its external validity.

From **Katrin Borchering** and **Detlof von Winterfeldt** [addresses above]:

### **The Effects of Varying Value Trees on Multiattribute Evaluations**

This experiment examines the effects of varying the super- and substructure of value trees on the weights in multiattribute utility modes. The value trees were variations of a tree used by the U. S. Department of Energy in its evaluation of alternative nuclear waste disposal sites. Using a questionnaire, 200 subjects assigned weights to the objectives and attributes in these trees according to four weighting procedures: Ratio, Swing, Trade-Off and Pricing-Out. There was a sizeable difference among weighting methods, in particular in that the pricing-out method assigned much more weight to the monetary attributes, while the other methods tended to weight health and safety aspects the highest. Objectives that were higher in the tree and that were described by more attribute detail, tended to receive a higher weight than those that were lower in the tree and were less detailed. However, these effects varied substantially among weighting methods. The results suggest a careful study of criteria for developing "appropriate" value trees.

From **Jeff T. Casey**, Harriman School of Management and Policy, SUNY-Stony Brook, Stony Brook, NY 11794-3775:

### **Bidding to Buy Risky Options: Contingent Strategies and Preference Reversals**

The *preference reversal phenomenon* -- a well established violation of the invariance principle of rational choice -- occurs when a decision maker chooses a high probability, low payoff "P bet" over a low probability, high payoff "\$ bet", but sets a higher buying or selling price for the \$ bet. An experiment is reported which replicated, using real money payoffs, a previous finding (Casey, in press) that an *opposite preference reversal pattern* occurs when the bets' maximum payoffs are large (\$100+) and choices are compared with maximum buying prices. Additionally, this and a second experiment revealed a new anomaly: Maximum buying prices for large bets did not converge toward expected value as probability of winning neared 1. This result implies that the conventional representation of the buying price for a risky option as a reduction in the option's payoffs fails to describe behavior. Neither of these findings are consistent with expected utility theory, even if wealth or income effects are considered. Instead, a *contingent anchor* model of bidding is proposed in which, for large positive bets, buyers anchor on the minimum payoff and adjust upward, while sellers anchor on the maximum payoff and adjust downward. In prospect theory (Kahneman & Tversky, 1979) terms, this model implies (1) buyers *segregate* the buying price from the bet and encode the buying price as a *sure loss*, (2) buyers' value functions are steeper both above and below

the status quo in bidding than in choosing, and (3) sellers are less risk averse in bidding than in choosing. This model captures both types of preference reversals as well as patterns of buying and selling prices. Implications for utility assessment and predicting gaps between willingness to pay and compensation demanded are discussed.

### **Predicting Buyer-Seller Gaps for Risky and Riskless Options**

A number of recent studies have found that, despite incentives to reveal true preferences, compensation demanded (CD) to give up a good or entitlement often greatly exceeds willingness to pay (WTP) to obtain it. Observed CD/WTP gaps are too large to be attributable to wealth or income effects, and thus violate standard assumptions of economic rationality. Whereas previous studies have focused on whether CD/WTP gaps are real, replicable phenomena, we propose a set of prospect theory (Kahneman & Tversky, 1979) based models capable of predicting the *sizes* of gaps depending primarily on the option's probability, the parties' loss aversion, and, most importantly, how the buyer and seller encode the prospective transaction. Two encoding processes are considered which give rise to four possible loci of CD/WTP gaps, three of which involve endowment effects. The usefulness of these models for identifying the loci of gaps is illustrated in two experiments. Whereas gaps for small, riskless goods have been attributed to endowment effects on the part of sellers (Knetsch, Thaler & Kahneman, 1989), the present results suggest gaps for large, risky bets are due to endowment effects on the part of *buyers*. It is concluded that a *contingent* encoding/endowment effect model is needed to predict shifts in the loci and sizes of CD/WTP gaps across situations. Several situational factors that may determine encoding processes are discussed.

From Jeff T. Casey and John T. Scholz [at Jeff Casey's address above]:

### **Boundary Effects of Vague Risk Information on Taxpayer Decisions**

In compliance decisions, the decision maker usually has only vague or ambiguous knowledge of the probability of being caught and the outcome (amount of penalty). An experiment is reported which extends work on effects of probability ambiguity by manipulating outcome ambiguity as well. When outcomes were limited to a bounded range and probabilities ranged between their natural boundaries [0,1] in experimental tax decisions, symmetrical *boundary effects* were found in which vague estimates for both the probability *and outcome* dimensions caused vagueness aversion (and higher compliance) when the vague estimate was near the more favorable lower boundary of either dimension and vagueness seeking (and lower compliance) when the vague estimate was near the less favorable upper boundary. Probability and outcome vagueness effects were found to be independent of the vagueness of the other dimension, and vagueness effects were not systematically related to the level of the the dimension.

The results suggest that a common cognitive process mediates the impact of vagueness on both dimensions. This may be a *vagueness-adjustment process* in which vague estimates are adjusted toward the middle of the bounded range, or a *vagueness-preference process* in which vague outcomes, and vague probabilities as well, are evaluated based on utility considerations, as though probability were a tangible commodity. For increasing compliance, the results suggest that risk information should be disseminated only when risks of punishment are relatively high. When risks are low, random enforcement techniques that enhance vagueness become more effective.

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

### **Signed Orders and Power Set Extensions**

The practical necessity of estimating preferences between subsets of an  $n$ -item set from preferences between the items themselves has long been recognized. Many conditions and methods for extending item preferences to subset preferences have been proposed. This paper explores a new basis for extension that can be expressed almost as simply as an ordering of items but contains a great deal more information for the extension task. The new basis, called a self-reflecting signed order, interweaves preferences for the inclusion of items in a subset and preferences for exclusion of items from the subset. If it is more important to you that person  $x$  *not* be on the committee than that  $y$  be on, your signed order records this information. Properties of self-reflecting signed orders and defensible conditions for their extension to subset preferences are studied.

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

### **Multiattribute Risk Linearity**

In choosing a multiattribute utility model, one typically assumes that preferences satisfy the condition of mutual utility independence and uses a multiattribute utility function that is either additive or multiplicative. This paper discusses a multiattribute utility model in which this condition is not satisfied, that is, risk attitude for one attribute depends on the amounts of the other attributes. We introduce a condition on this dependence called "multiattribute risk linearity" that implies a logarithmic form for the multiattribute utility function. For a multiattribute utility function having this type of structure, we describe assessment procedures that are equally difficult as those for a multiplicative utility function.

From **Ralph L. Keeney** and **Detlof von Winterfeldt**, Institute of Safety and Systems Management, University of Southern California, Los Angeles, CA 90089, and **Thomas Eppel**, Krannert Graduate School of Management, Purdue University, West Lafayette, IN 47907:

### **Eliciting Public Values for Complex Policy Decision**

Several approaches exist to illuminate and clarify public values relevant for making public policy decisions. These include surveys, indirect and direct value elicitation, focus groups and public involvement. This paper describes a new approach, called the public value forum, which combines elements of focus groups and direct multiattribute value elicitation techniques. Two public value forums were conducted with selected members of the West German public to elicit values relevant for setting long term energy policies. The purposes of conducting the value forums were to examine the feasibility of eliciting values from laypeople and combining them with factual assessments of experts, to determine the extent to which values elicited formally conflict with values elicited informally, and to assess the advantages and disadvantages of the public value forum. The results indicate that the public value forum is feasible, that the participants felt comfortable with the procedure and that they were eager to resolve inconsistencies between their intuitive judgments and the multiattribute models. There was substantial conflict between the formally and informally elicited values. However, the participants were able to resolve those conflicts in the course of the value forum, tending towards more moderate alternatives in the process. The public value forum provided useful information for the policy process and education for the participants. However, because it is

expensive and time consuming, its main application may involve small samples of opinion leaders and stakeholders representatives, rather than large representative samples of the general public.

From **Craig W. Kirkwood** and **James L. Corner**, Dept. of Decision and Information Systems, College of Business, Arizona State University, Tempe, AZ 85287-4206:

#### **The Effectiveness of Partial Information About Attribute Weights for Ranking Alternatives in Multiattribute Decision Making.**

Weighted additive evaluation functions are widely used to rank alternatives in decision making under certainty with multiple evaluation attributes. Some researchers have suggested that approximate attribute weights may be adequate to accurately rank alternatives. Use of approximate weights would simplify decision analysis since detailed elicitation of weights can be time consuming and controversial. This article investigates the degree to which partial information about attribute weights is sufficient to rank alternatives as a function of the number of decision alternatives, the number of attributes, and the number of levels of distinction for each attribute. A simulation analysis, as well as re-analysis of actual applications, shows that partial information about weights is often not sufficient to determine the most preferred alternative for realistic decision problems. Hence, approximation procedures for specifying weights may lead to errors. However, our work also shows that a simple analysis procedure can be used to accurately determine whether partial information about weights is adequate to correctly specify the most preferred alternative. This procedure can be useful for identifying situations in which detailed elicitation of weights is not needed.

#### **Documentation of Computer Programs Used in "The Effectiveness of Partial Information About Attribute Weights for Ranking Alternatives in Multiattribute Decision Making"**

This report documents the two computer programs used for the analysis in the paper "The Effectiveness of Partial Information about Attribute Weights for Ranking Alternatives in Multiattribute Decision Making." The two computer programs aid in determining the extent to which attribute weights influence the choice of the most preferred alternative in multiattributed decisions analyzed under certainty. Specifically, RPIS (Ranking with Partial Information Simulator) is a simulation program which explores the extent to which certain partial information about attribute weights is sufficient to select the most preferred alternative from a specified number of alternatives. RPIA (Ranking with Partial Information Analyzer) is an analysis program which, given qualitative information about attribute weights, rank-orders alternatives for a specified decision problem using a variety of different procedures. Both programs use the Kirkwood-Sarin rank-ordering algorithm while the latter program also uses equal, rank sum, rank reciprocal, and rank exponent weighting approximations for comparison purposes. Examples of the use of each program are included.

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

#### **Arbitrage, Rationality, and Equilibrium**

No-arbitrage is the fundamental principle of economic rationality which unifies normative decision theory, game theory, and market theory. In economic environments where preferences may be assumed to be convex and money is available as a medium of exchange, no-arbitrage supports the concepts of subjective expected utility maximization in personal decisions, competitive equilibria in capital markets and exchange economies, and correlated equilibria in noncooperative games. The arbitrage principle directly characterizes rationality at the market level; apparent optimizing behavior

by individual agents is viewed as a consequence of their adaptation to the market. Concepts of equilibrium behavior in games and markets can thus be reconciled with the ideas that individual rationality is bounded, that agents use evolutionarily-shaped decision rules rather than numerical optimization algorithms, and that personal probabilities and utilities are inseparable and to some extent indeterminate. Risk-neutral probability distributions, interpretable as products of probabilities and marginal utilities, play a central role as observable quantities in economic systems.

From **Jayavel Sounderpandian**, School of Business, University of Wisconsin-Parkside, Wood Road, Box 2000, Kenosha, WI 53141-2000:

#### **Value Functions When Decision Criteria Are Not Totally Substitutable**

A necessary condition for the widely used additive value function is total preferential independence, or somewhat equivalently, total substitutability among the decision criteria. We consider cases where total substitutability is absent, and study the value functions that are applicable to such cases. First we take the case of total nonsubstitutability, and prove that the maximin value function is appropriate for it. This result easily extends to the closely related maximax value function. Next we consider the case where there is neither total substitutability nor total nonsubstitutability, and show how a "minsum" value function can be applicable. A minsum function is one which uses only addition and minimum extraction operations. We explain how the structure of a minsum function can be inferred from substitutability information. In the process, we encounter certain subsets of criteria which we have called chains and cuts.

#### **Transforming Continuous Utility Into Additive Utility Using Kolmogorov's Theorem**

A famous theorem due to Kolmogorov is used to show that if a decision problem has  $\mathbf{R}^n$  as the criteria space, and if it has a continuous utility function, then the criteria space can be transformed into  $\mathbf{R}^{2n+1}$  so that there will be an additive utility function. The absence of separability requirement is noteworthy. Some comments about the implications of this result are added at the end.

From **James S. Weber**, School of Business Administration, University of Wisconsin-Milwaukee, Milwaukee, WI 53201:

#### **The Generalized Condorcet Paradox**

We characterize the possibility of generalized majority rule cyclicity by giving strong upper and lower bounds on the number of voters,  $V$ , the number of alternatives,  $A$ , and the number required for a majority,  $M$ . Our elementary proof uses an argument not previously reported in the literature.

From **Rami Zwick**, Department of Marketing, 701N Business Administration Building, The Pennsylvania State University, University Park, PA 16802 (R1Z@PSUVM), **Amnon Rapoport**, The University of Arizona, and **John C. Howard**, the Pennsylvania State University.

#### **Two-Person Sequential Bargaining Behavior With Exogenous Breakdown.**

Adopting the strategic approach to two-person bargaining, we examine bargaining behavior in a noncooperative game in which two bargainers alternate in making and responding to proposals over the division of a given surplus. Although the number of bargaining periods is unlimited and



time is not discounted, the bargaining is subject to exogenous breakdown at each period with a fixed probability that is common knowledge. We manipulate three probabilities of breakdown in a between-subject design that allows comparison with previous studies of two-person bargaining with time discounting. Like in most previous studies, our results reject both the subgame perfect equilibrium and equal split solutions. For a substantial percentage of the subjects the analysis reveals adaptive behavior over games characterized as a systematic search by the player starting the negotiations for the highest acceptable demand.

From **Eythan Weg**, Economic Science Laboratory, College of Business and Public Administration, University of Arizona, Tucson, AZ 85721, (WEG@CONVX0.CCIT.ARIZONA.EDU), and **Rami Zwick**, The Pennsylvania State University.

**The Robustness of Perfect Equilibrium in Fixed Cost Sequential Bargaining: A Framing Context.**

Subgame perfect Equilibrium realizations in sequential bargaining with fixed costs structures under positive and negative frames are studied. No effects for frame or experience are found. The strong prevalence of the PE outcomes is discussed in the context of the fairness constraint found in other studies.