



## Decision Analysis

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## From the Editors: *Decision Analysis* Focus and Trends

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Expected-utility decision theory (the focus of *Decision Analysis*) provides a structured process of decision making based on axiomatic concepts of rationality as developed by some of the greatest minds of the 20th century. In particular, the philosopher Frank Ramsey (1931) pioneered the idea of subjective probability as a way of expressing an individual's beliefs or uncertainties. Then, in the 1940s, as part of their development of game theory, the mathematician John von Neumann and the economist Oskar Morgenstern developed the idea of utility theory (now a mainstay of economics) as a way of expressing an individual's preferences over possible outcomes (von Neumann and Morgenstern 1947). The statistician Leonard Jimmie Savage (1972, originally published 1954) then presented an alternate axiomatization. The resulting expected-utility theory provides a complete axiomatic basis for decision making under uncertainty, which has since been summarized and further developed by others as documented in foundational works such as Raiffa (1968), Keeney and Raiffa (1976), von Winterfeldt and Edwards (1986), and Howard (1988).

Today, expected-utility decision theory is justified by much more than its axiomatic basis. It is an applied subject (justified by the success of its applications) and a tool for communication in deliberation of major business and societal issues as well as in more-focused decisions. Its foundations in subjective probability and Bayesian statistics link it to much of machine learning and analytics. Moreover, elicitation and modeling procedures have developed to aid decision makers in recognition of the fact that real-world decision makers

may not be as rational as the axioms demand. They may wish to be, but as Ward Edwards (1954) foresaw, unguided human decision making can fall afoul of behavioral biases. Psychological and behavioral studies have confirmed this in many ways; see, for example, the work of Nobel Prize-winner Daniel Kahneman (2011). Our elicitation procedures recognize and attempt to counter such biases. Thus, today, the multi-disciplinary body of knowledge contributing to decision theory is wide-ranging, as summarized in, for instance, Brown (2005), Edwards et al. (2007), French et al. (2009), Keeney (2009), Clemen and Reilly (2013), Gregory et al. (2013), Cox (2015), Howard and Abbas (2015), and Spetzler et al. (2016).

The aim of the journal *Decision Analysis* is to report on continued developments and advances in this body of work and to highlight seminal applications. We recognize that other theories of decision making have been developed—some close to ours, others more distant. The journal is open to a wide variety of interdisciplinary work on decision making. However, all authors seeking to publish in *Decision Analysis* should, at a minimum, be familiar with expected-utility decision theory and how we apply it and should put their work in context with the paradigm of expected-utility decision theory even if they themselves hold to a different paradigm. Thus, *Decision Analysis* welcomes contributions that challenge the boundaries of the field—for example, by showing how concepts, ideas, or methods from other fields (such as game theory, economics, behavioral finance, psychology, consumer behavior, or other approaches) can improve or extend the theory

and practice of decision theory—but such papers should be framed to be of interest (and persuasive) to readers of the journal.

Within the area of decision theory broadly defined, *Decision Analysis* is open to contributions on a wide variety of different topics. Examples include, but are not limited to, the following:

- contributions to the foundational theories of subjective probability, value, and utility functions;
- new procedures, processes, or algorithms for implementing decision theory;
- cognitive, psychological, organizational, economic, policy, or social issues relating to decision theory;
- innovative uses of information technology to support the application of decision theory; and
- important and/or novel applications of decision theory to real-world situations.

## Methodological and Theoretical Contributions

Many of the papers published by *Decision Analysis* are primarily methodological contributions. Such manuscripts should ideally be written in a manner in which at least the main ideas are understandable to nonspecialists (with complicated mathematical proofs preferably relegated to an appendix or online supplementary material to enhance readability). For example, papers on Bayesian statistics should be understandable to utility theorists, papers on utility theory should be understandable to probability theorists, and both should be understandable to educated practitioners. Examples and/or graphics to illustrate the methodology are also helpful as are discussions of the range of problems to which the method could be applicable and possible extensions.

As can be seen from Table 1, the methodology papers from the last two years are mostly motivated by applications (Daley and Wang 2018, Hounwanou 2018, Karimi and Dimitrov 2018, Khoroshilov 2018, Kvam 2018, Metel 2018, Abbas and Sun 2019, Baucells and Sarin 2019, Grant et al. 2019, Hadlock and Bickel 2019, Hausken 2019, Phade and Anantharam 2019). We put them in the methodology category either because the intended applications are quite general (e.g., typical business decisions) or because they deal with “toy” problems chosen to illustrate the method and are unlikely to be widely applied in the real world—for

example, game shows (Kvam 2018) or horse betting (Metel 2018). A few can be described as “pure” methodology or theory papers (e.g., Grant et al. 2019, Hadlock and Bickel 2019, Phade and Anantharam 2019); even then, however, the goal is either to support applications or to create tools or results that can be used in future research.

In keeping with recent trends in business, industry, government, and society as a whole, *Decision Analysis* is also becoming more interested in methods of data analytics, machine learning, and artificial intelligence. There are overlaps between these methodologies and the methods of expected-utility decision theory. Papers that explore these relationships (what analytics can bring to decision theory and how a decision-theoretic perspective can help to inform analytics) would be more than welcome. Although this has not been a major emphasis so far, we did recently publish a special issue on uses of social media (Allen et al. 2017, Bigsby et al. 2017, Bogaert et al. 2017, Rathore et al. 2017), which can give some indication of the types of approaches that might be relevant to our readers.

In general, for any methodology paper, overly-grandiose claims about the merits of a proposed method are strongly discouraged. Unsupported claims on the order of “the proposed method is more accurate than any other methods” are less helpful than balanced conclusions discussing both strengths and weaknesses of the work.

## Group, Organizational, and Societal Decision Making

Many important real-world decisions (perhaps the majority of them!) are the responsibility of multiple people, in either government or industry and other organizations. However, subjective probability and expected utility as initially developed are essentially single-person theories; the beliefs and preferences that they encapsulate are inherently individualistic, and the axioms of expected-utility decision theory are not prescriptive for groups.

Papers in this area might explore how ideas from expected-utility decision theory can help to support group decision processes (e.g., Keeney 2013)—for example, by using values hierarchies to facilitate stakeholder communication and the development of consensus. However, it is also of interest to explore how group processes may need to depart from traditional decision theory and

**Table 1.** Papers Published in *Decision Analysis* in 2018 and 2019

| Methodological and theoretical contributions                                                                                                                                                     |                                        |                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------|
| Participation Costs and Inefficiency in Takeover Contests, <a href="https://doi.org/10.1287/deca.2017.0356">https://doi.org/10.1287/deca.2017.0356</a>                                           | Hounwanou (2018)                       | Vol. 15, No. 1 |
| When to Release Feedback in a Dynamic Tournament, <a href="https://doi.org/10.1287/deca.2017.0357">https://doi.org/10.1287/deca.2017.0357</a>                                                    | Daley and Wang (2018)                  | Vol. 15, No. 1 |
| Kelly Betting on Horse Races with Uncertainty in Probability Estimates, <a href="https://doi.org/10.1287/deca.2017.0359">https://doi.org/10.1287/deca.2017.0359</a>                              | Metel (2018)                           | Vol. 15, No. 1 |
| On the Road to Making Science of “Art”: Risk Bias in Market Scoring Rules, <a href="https://doi.org/10.1287/deca.2017.0362">https://doi.org/10.1287/deca.2017.0362</a>                           | Karimi and Dimitrov (2018)             | Vol. 15, No. 2 |
| Partnership Dissolution: Information and Efficiency, <a href="https://doi.org/10.1287/deca.2018.0367">https://doi.org/10.1287/deca.2018.0367</a>                                                 | Khoroshilov (2018)                     | Vol. 15, No. 3 |
| A Probability Model for Strategic Bidding on “The Price Is Right,” <a href="https://doi.org/10.1287/deca.2018.0373">https://doi.org/10.1287/deca.2018.0373</a>                                   | Kvam (2018)                            | Vol. 15, No. 4 |
| The Generalized Johnson Quantile-Parameterized Distribution System, <a href="https://doi.org/10.1287/deca.2018.0376">https://doi.org/10.1287/deca.2018.0376</a>                                  | Hadlock and Bickel (2019)              | Vol. 16, No. 1 |
| Principal-Agent Theory, Game Theory, and the Precautionary Principle, <a href="https://doi.org/10.1287/deca.2018.0380">https://doi.org/10.1287/deca.2018.0380</a>                                | Hausken (2019)                         | Vol. 16, No. 2 |
| The Myopic Property in Decision Models, <a href="https://doi.org/10.1287/deca.2018.0384">https://doi.org/10.1287/deca.2018.0384</a>                                                              | Baucells and Sarin (2019)              | Vol. 16, No. 2 |
| On the Geometry of Nash and Correlated Equilibria with Cumulative Prospect Theoretic Preferences, <a href="https://doi.org/10.1287/deca.2018.0378">https://doi.org/10.1287/deca.2018.0378</a>    | Phade and Anantharam (2019)            | Vol. 16, No. 2 |
| Archimedean Utility Copulas with Polynomial Generating Functions, <a href="https://doi.org/10.1287/deca.2018.0386">https://doi.org/10.1287/deca.2018.0386</a>                                    | Abbas and Sun (2019)                   | Vol. 16, No. 3 |
| A Probability Scoring Rule for Simultaneous Events, <a href="https://doi.org/10.1287/deca.2019.0393">https://doi.org/10.1287/deca.2019.0393</a>                                                  | Grant et al. (2019)                    | Vol. 16, No. 4 |
| Behavioral research                                                                                                                                                                              |                                        |                |
| Impact of Compound and Reduced Specification on Valuation of Projects with Multiple Risks, <a href="https://doi.org/10.1287/deca.2017.0358">https://doi.org/10.1287/deca.2017.0358</a>           | Bansal and Rosokha (2018)              | Vol. 15, No. 1 |
| Moment Risks: Investment for Self and for a Firm, <a href="https://doi.org/10.1287/deca.2018.0372">https://doi.org/10.1287/deca.2018.0372</a>                                                    | Desmoulins-Lebeault and Meunier (2018) | Vol. 15, No. 4 |
| Characterizing Conflicting User Values for Cyber Authentication Using a Virtual Public Values Forum, <a href="https://doi.org/10.1287/deca.2018.0383">https://doi.org/10.1287/deca.2018.0383</a> | Kusumastuti et al. (2019)              | Vol. 16, No. 3 |
| Misperception of Exponential Growth: Are People Aware of Their Errors?, <a href="https://doi.org/10.1287/deca.2019.0395">https://doi.org/10.1287/deca.2019.0395</a>                              | Cordes et al. (2019)                   | Vol. 16, No. 4 |
| Elicitation methods and approaches                                                                                                                                                               |                                        |                |
| Optimizing Choice Architectures, <a href="https://doi.org/10.1287/deca.2018.0379">https://doi.org/10.1287/deca.2018.0379</a>                                                                     | Schneider et al. (2019)                | Vol. 16, No. 1 |
| Improving Accuracy by Coherence Weighting of Direct and Ratio Probability Judgments, <a href="https://doi.org/10.1287/deca.2018.0388">https://doi.org/10.1287/deca.2018.0388</a>                 | Fan et al. (2019)                      | Vol. 16, No. 3 |
| Sparse Probability Assessment Heuristic Based on Orthogonal Matching Pursuit, <a href="https://doi.org/10.1287/deca.2019.0389">https://doi.org/10.1287/deca.2019.0389</a>                        | Huang and Bickel (2019)                | Vol. 16, No. 4 |

**Table 1.** (Continued)

| Applications and case studies                                                                                                                                                                                             |                                 |                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----------------|
| Modeling and Validating Public–Private Partnerships in Disaster Management, <a href="https://doi.org/10.1287/deca.2017.0361">https://doi.org/10.1287/deca.2017.0361</a>                                                   | Guan et al. (2018)              | Vol. 15, No. 2 |
| When Hackers Err: The Impacts of False Positives on Information Security Games, <a href="https://doi.org/10.1287/deca.2017.0363">https://doi.org/10.1287/deca.2017.0363</a>                                               | Mai and Kulkarni (2018)         | Vol. 15, No. 2 |
| Eliminating the Weakest Link Approach to Army Unit Readiness, <a href="https://doi.org/10.1287/deca.2017.0366">https://doi.org/10.1287/deca.2017.0366</a>                                                                 | Goethals and Scala (2018)       | Vol. 15, No. 2 |
| Insights for Critical Alarm-Based Warning Systems from a Risk Analysis of Commercial Aviation Passenger Screening, <a href="https://doi.org/10.1287/deca.2018.0369">https://doi.org/10.1287/deca.2018.0369</a>            | Dillon et al. (2018)            | Vol. 15, No. 3 |
| Role of Intelligence Inputs in Defending Against Cyber Warfare and Cyberterrorism, <a href="https://doi.org/10.1287/deca.2018.0370">https://doi.org/10.1287/deca.2018.0370</a>                                            | Bagchi and Bandyopadhyay (2018) | Vol. 15, No. 3 |
| Eliciting Public Risk Preferences in Emergency Situations, <a href="https://doi.org/10.1287/deca.2018.0371">https://doi.org/10.1287/deca.2018.0371</a>                                                                    | Taheri and Wang (2018)          | Vol. 15, No. 4 |
| Securing Gates of a Protected Area: A Hybrid Game and Queueing Theory Modeling Approach, <a href="https://doi.org/10.1287/deca.2018.0375">https://doi.org/10.1287/deca.2018.0375</a>                                      | Deutsch and Golany (2019)       | Vol. 16, No. 1 |
| Two-Stage Invest–Defend Game: Balancing Strategic and Operational Decisions, <a href="https://doi.org/10.1287/deca.2018.0377">https://doi.org/10.1287/deca.2018.0377</a>                                                  | Yolmeh and Baykal-Gursoy (2019) | Vol. 16, No. 1 |
| Gulf Coast Port Selection Using Multiple-Objective Decision Analysis, <a href="https://doi.org/10.1287/deca.2018.0381">https://doi.org/10.1287/deca.2018.0381</a>                                                         | De Icaza et al. (2019)          | Vol. 16, No. 2 |
| Information Sharing in Cybersecurity: A Review, <a href="https://doi.org/10.1287/deca.2018.0387">https://doi.org/10.1287/deca.2018.0387</a>                                                                               | Pala and Zhuang (2019)          | Vol. 16, No. 3 |
| Computational Efficiency in Multivariate Adversarial Risk Analysis Models, <a href="https://doi.org/10.1287/deca.2019.0394">https://doi.org/10.1287/deca.2019.0394</a>                                                    | Perry and El-Amine (2019)       | Vol. 16, No. 4 |
| Perspective pieces                                                                                                                                                                                                        |                                 |                |
| Decision Analysis and Political Processes, <a href="https://doi.org/10.1287/deca.2018.0374">https://doi.org/10.1287/deca.2018.0374</a>                                                                                    | French and Argyris (2018)       | Vol. 15, No. 4 |
| Probability Forecasts and Their Combination: A Research Perspective, <a href="https://doi.org/10.1287/deca.2019.0391">https://doi.org/10.1287/deca.2019.0391</a>                                                          | Winkler et al. (2019)           | Vol. 16, No. 4 |
| Methodologies other than expected-utility decision theory                                                                                                                                                                 |                                 |                |
| The Hurwicz Decision Rule’s Relationship to Decision Making with the Triangle and Beta Distributions and Exponential Utility, <a href="https://doi.org/10.1287/deca.2018.0368">https://doi.org/10.1287/deca.2018.0368</a> | Sivaprasad and MacKenzie (2018) | Vol. 15, No. 3 |

how those processes may depend on the nature of the group (e.g., small, face-to-face groups versus societal-level, political decisions). For example, possible topics may include impossibility—or possibility!—theorems for group decisions as well as methods for bargaining, negotiation, or voting guided by ideas of Bayesian rationality. Developments in game theory and adversarial

risk analysis are also welcome (and we have already published numerous papers in that area as discussed under Applications).

## Behavioral Research

The journal is receptive to papers in cognitive psychology, behavioral economics, or similar fields provided



there is a clear link to improving decision making. Papers that merely illustrate the existence of some behavioral or psychological phenomenon would probably be more appropriate for an applied-psychology journal. However, if there is a clear link to how a phenomenon might affect decision making (e.g., how a particular phenomenon might lead to predictable biases in choices) or clear implications for best practices in probability or utility elicitation, such work would be highly relevant to readers of *Decision Analysis*. Discussions of behavioral issues involved in communicating decision analyses and their conclusions to decision makers (and other stakeholders) are also relevant to the journal although, again, general papers on risk communication might more suitable for an applied-psychology or risk-related journal.

The journal has not published a lot of purely behavioral research in the last two years although examples include Bansal and Rosokha (2018), Desmoulin-Lebeault and Meunier (2018), Cordes et al. (2019), and Kusumastuti et al. (2019); some papers discussed in the next section (on elicitation methods) are also behavioral. Although methodology papers sometimes cover topics of behavioral interest (see, for example, Phade and Anantharam (2019) on prospect theory), behavioral papers are distinguished by their reliance on laboratory experiments, questionnaires, or other empirical methods of characterizing individuals' actual judgments or choice behaviors. Again, behavioral research in *Decision Analysis* is typically oriented toward supporting improved real-world decision making (e.g., in finance or cybersecurity).

### Elicitation Methods and Approaches

Papers on all aspects of probability, value, and utility elicitation are welcome, including both behavioral and mathematical approaches. For example, such work could address the aggregation of subjective probabilities elicited from several experts or the formation of group utility functions from multiple decision makers and/or stakeholders. Often, elicitation is undertaken in decision conferences and/or stakeholder workshops, so we would welcome well-supported papers on how best to facilitate such events provided they contribute something new rather than just restating what is known. Papers on the process of working with decision makers and other experts to build decision

models or to generate better alternatives would also be welcome.

Contributions on elicitation and aggregation can range from behavioral experiments (Fan et al. 2019, Schneider et al. 2019) to mathematical methods or heuristics (Huang and Bickel 2019). Such papers could have been characterized as methodological or behavioral, but we highlight them in a separate category because elicitation is of central importance to the practice and continued improvement of expected-utility decision theory.

### Applications and Case Studies

The journal is open to papers applying expected-utility decision theory or related methods to real-world decisions. However, such papers need to be of reasonably broad interest and bring insights that go beyond merely solving a specific problem for an individual client. This could be because the nature of the application requires some methodological innovation, which could then be used by analysts working on other types of applications. A good question to ask about such papers is whether practitioners would learn something useful from the case study that could be beneficial in their future practice. Alternatively, applications papers may also be viewed favorably if the topic itself is of broad and current interest.

Over the last two years, applications papers in *Decision Analysis* have focused overwhelmingly on topics related to security and emergency management (Bagchi and Bandyopadhyay 2018, Dillon et al. 2018, Goethals and Scala 2018, Guan et al. 2018, Mai and Kulkarni 2018, Taheri and Wang 2018, De Icaza et al. 2019, Deutsch and Golany 2019, Pala and Zhuang 2019, Perry and El-Amine 2019, Yolmeh and Baykal-Gursoy, 2019). However, this trend was driven by the nature of the submissions received and should not be taken as a limitation on the types of papers that can succeed in *Decision Analysis*. Examples of other applied topics of interest to the journal include entrepreneurship (Bodily 2016), insurance (Meeker et al. 2015, Bodily and Furman 2016), and medical decision making (Alagoz et al. 2013, Nohdurft et al. 2017).

As can be seen from perusal of the papers cited here, most applications papers in *Decision Analysis* involve some methodological contribution needed to address a particular aspect of the applications domain. They are

distinguished from pure methodology papers by the special-purpose nature of the methodology, which may be of limited use in other domains. However, case studies involving the application of known methods may be of interest if they concern problems of significant importance, such as military readiness (Goethals and Scala 2018) or global supply chains (De Icaza et al. 2019).

Papers that present a straightforward application of conventional methods to a topic that is not of broad public or policy interest should probably be submitted to a journal in the relevant application area (e.g., accounting, manufacturing, telecommunications, etc.). Such work can be of great value but is of greater interest to readers in the relevant field and can also help educate such readers about formal methods of decision making. The fact that an applications paper may not be considered suitable for *Decision Analysis* should not be taken as a negative judgment on the quality of the work, but only about the most suitable audience for that work.

### Perspective Pieces

*Decision Analysis* does occasionally publish pieces that provide an overview of trends in a given field but do not fit clearly into the methodological, empirical, or applications categories. Examples within the last two years include French and Argyris (2018) on use of decision analysis in the political process and Winkler et al. (2019) on probabilistic forecasting. See also Rathore et al. (2017) on social media analytics. Papers in this category are typically written or coauthored by well-established researchers or practitioners.

### Pedagogy: Skills and Professional Development

The journal is open to papers discussing pedagogical issues in the teaching of expected-utility decision theory and related methods. Examples include the development of novel educational materials or approaches to support experiential learning in decision analysis (e.g., Bickel 2010), ways to incorporate decision-theoretic content into other classes (such as statistics or engineering economics), or ways to strengthen “soft skills” (elicitation techniques, etc.) among practitioners.

### Methodologies Other than Expected-Utility Decision Theory

Of course, people’s expressed preferences and beliefs may not be consistent or even fully match the axioms of rational choice. For example, people are dismayingly susceptible to framing effects (Tversky and Kahneman 1986, Stewart et al. 2015) and are subject to other behavioral phenomena, such as ambiguity aversion (Ellsberg 1961, Baillon et al. 2018, Li et al. 2018), the probability weighting of prospect theory (Kahneman and Tversky 1979), and regret (Bell 1983). Therefore, *Decision Analysis* is open to papers from other perspectives, especially if they help to address one or more of these phenomena. Papers providing a balanced comparison of several decision methodologies would also be welcome. A recent example of a paper that provides a decision-analytic perspective on a non-decision analytic method is Sivaprasad and MacKenzie (2018), showing the conditions under which a well-known nonprobabilistic decision rule yields results equivalent to those of expected-value or expected-utility decision theory.

However, authors using methodologies other than expected utility should discuss any pitfalls of those methods and address why they believe that either those pitfalls are unlikely to be significant in their application or the merits of the proposed method outweigh any disadvantages. For example, some non-expected utility methods can give rise to preference reversals through the addition of irrelevant (nonpreferred) alternatives (Dyer 1990, Verly and De Smet 2013). This does not mean that such methods should never be used; for example, the types of judgments required for a given method may be easier or more intuitive for some decision makers than the judgments required to assess utility functions. However, methods that are subject to preference reversals (i.e., that violate axioms regarding independence of irrelevant alternatives) are unlikely to fare well in the review process if the authors do not even discuss the possibility of preference reversals.

Likewise, authors using non-decision theoretic methods should attempt to apply the best practices of decision analysis (e.g., Keeney 2002) to the extent possible. For example, methods that ask decision makers

to assign weights to multiple attributes without explicitly considering the ranges over which those attributes vary are again unlikely to fare well in the review process (Fischer 1995).

## Concluding Thoughts

Overall, *Decision Analysis* is open to a wide variety of types of articles in keeping with the idea that expected-utility decision theory is itself inherently a multidisciplinary field, involving contributions from mathematics, economics, statistics, psychology, and others. However, the journal remains focused on advancing the theory, application, and teaching of expected-utility decision theory as described at the beginning of this editorial. Authors who are unsure whether a particular manuscript fits the scope of the journal are welcome to contact the editor-in-chief directly with inquiries.

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