

**BA591 – Prescriptive Models for Decision Analysis  
Fall, 2003**

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Day and time: Thursday, 2:00 – 5:00 PM  
Classroom: Fuqua School of Business, Seminar Room 1 (First class only, Aug 28)  
Fuqua School of Business, Seminar Room 2 (Sept 4 – Dec 11)

**Course Description**

Decision analysis has the ultimate aim of helping decision makers with real-world choices. This course introduces students to the theory and practice of decision analysis. We will study the tools and methods that decision analysts use, with an emphasis on understanding where these tools and methods come from. Our readings will take us from basic textbooks to original articles and readings from areas such as foundational decision theory, operations research and management science, economics, and the psychology of decision making.

The course has four specific objectives:

1. Learn basic decision analysis tools and methods.
2. Develop familiarity with central topics and issues in decision analysis by studying classic articles.
3. Learn about the current state the field, current research issues, and hot topics by studying current articles.
4. Learn to critique decision analysis articles.

**Deliverables**

Each student will complete two assignments:

1. Present and discuss an article for the class. Each student will chose a different article from the syllabus. The presentation should include a summary and discussion of the paper's contributions, proof or derivation of key results if needed, and a critique of the model and or analysis. You are welcome to provide notes to your classmates. As a follow-up, you will hand in a written critique of the article. The critique should be on the order of 4-6 double-spaced pages, and should follow the general format of a referee report: Part 1 should summarize the article, including key results and highlights. Part 2 should describe any major issues that you have with the article, and Part 3 should indicate less crucial (or minor) issues. The critique will be due to me within a week after your in-class

presentation.

In the list of readings below, the articles that are marked with \* may be used to satisfy this requirement. Please let me know as soon as possible which article you would like to present. First come, first served! I'll be happy to provide guidance and recommendations based on your particular interests and background.

2. Complete a term paper on a topic of interest to you that is related to decision analysis. The topic could be an application of decision analysis, a review or essay on a specific research area or types of applications, or a prospective discussion of a specific research topic in decision analysis that you think should be done and/or that you might like to pursue. I will be glad to discuss possible topics with individual students. The paper is due no later than December 12.

In addition, of course, all students are expected to read the assigned material and to participate fully in our discussions of the readings. I'll also occasionally suggest problems for you to tackle; the objective of the problems is to have you practice the tools we cover and to push you to think more deeply and analytically about various topics. The problems are entirely optional.

### **Reading Material**

The text for the course is Clemen, *Making Hard Decisions*, 2<sup>nd</sup> Ed., 1996 (Belmont, CA: Duxbury Press), abbreviated *MHD*. (You can also use Clemen and Reilly, *Making Hard Decisions with DecisionTools*.) The book provides very basic reading to get you started with the concepts. Most of our time will be devoted to studying articles and book chapters that will take us beyond the material in *MHD*.

The readings for each day are listed in the schedule below. The articles for the first day can be downloaded from [http://faculty.fuqua.duke.edu/~clemen/BA591\\_DA/](http://faculty.fuqua.duke.edu/~clemen/BA591_DA/). All of the articles are available on the Fuqua Network I drive ("everyone") in a folder called "BA591 Prescriptive Models." I'll also be happy to make a CD containing the readings for anyone who would like one.

If there is material in *MHD* to read, please read it first. After that, feel free to read the research articles and chapters in any order. Note that review papers are sometimes included, always at the end of the list. Consider the review papers low priority. They are useful, but the sort of thing you can always go back to when necessary.

### **Tentative Schedule**

Session 1, Aug 28. Course Overview. What is decision analysis (DA)? Why use it? What is research in DA about?

Readings:

- *MHD*, Chapters 1-2
- R. Duncan Luce & Howard Raiffa (1957). *Games and decisions*. John Wiley, Sections 2.5-2.6.
- Howard Raiffa (2002). Decision analysis: A personal account of how it got started and evolved. *Operations Research*, 50, 179-185.

- Ronald A. Howard (1988). Decision analysis: Practice and promise. *Management Science*, 34, 1988.
- Ward Edwards & Barbara Fasolo (2001). Decision technology. *Annual Review of Psychology*, 52, 581-606.

Session 2, Sept 4. Structuring Decisions. Influence Diagrams. What are Influence Diagrams? How do they relate to decision trees? When should we use them? How is decision-relevant information represented in an influence diagram, and what is the expected value of perfect information (EVPI)?

Readings:

- *MHD*, Chapters 3-4, 12
- Ronald A. Howard & James E. Matheson (1981). Influence diagrams. In R. Howard & J. Matheson (Eds.), *Readings on the Principles and Applications of Decision Analysis, Vol II*, pp 719-762. Menlo Park, CA: Strategic Decisions Group.
- \*Ross D. Shachter (1986). Evaluating influence diagrams. *Operations Research*, 34, 871- 882.
- Review paper: Izhar Matzkevich & Bruce Abramson (1995). Decision analytic networks in artificial intelligence. *Management Science*, 41, 1-22.

Session 3, Sept 11. Negotiation Analysis. Class visitor: Howard Raiffa. How do negotiation problems differ from typical one-party decision making that we consider in DA? What does psychology say about how people behave in negotiations? What roles can analysis play in negotiations?

Readings:

- Howard Raiffa (2002). *Negotiation Analysis*, Chapter 5.
- Max H. Bazerman & Margaret A. Neale (1991). Negotiator rationality and negotiator cognition: The interactive roles of prescriptive and descriptive research. In H. Peyton Young (Ed.), *Negotiation Analysis*, pp 109-129. Ann Arbor: University of Michigan Press
- Ralph L. Keeney & Howard Raiffa (1991). Structuring and analyzing values for multiple-issue negotiations. In H. Peyton Young (Ed.), *Negotiation Analysis*, pp 131-151. Ann Arbor: University of Michigan Press

Session 4, Sept 18. Sensitivity Analysis. What is sensitivity analysis in general, and what are its special characteristics in DA? What do we mean by dominance (including stochastic dominance)? Is there any general theory that forms the basis of performing sensitivity analysis in DA? Is EVPI a reasonable measure of sensitivity?

Readings:

- *MHD*, Chapter 5
- Derek Bunn (1984). *Applied Decision Analysis*, New York: McGraw-Hill. Chapter 4.
- \*David Rios Insua & Simon French (1991). A framework for sensitivity analysis in discrete multi-objective decision-making. *European Journal of Operational Research*, 54, 176-190.

- James C. Felli & Gordon B. Hazen (1998). Sensitivity analysis and the expected value of perfect information. *Medical Decision Making*, 18, 95-109.

Session 5, Sept 25. Subjective Probability I: Basics. Where do subjective probabilities come from in DA? What some theories that underlie the use and assessment of subjective probabilities? How are probabilities assessed in practice?

Readings:

- *MHD*, Chapter 8
- Carl S. Spetzler & Carl-Axel Staël Von Holstein (1975). Probability encoding in decision analysis. *Management Science*, 22, 340-358.
- Ralph L. Keeney & Detlof von Winterfeldt (1991). Eliciting probabilities from experts in complex technical problems. *IEEE Transactions on Engineering Management*, 38, 191–201.

Session 6, Oct 2. Subjective Probability II: Prescriptive Analysis. What are some practical issues that arise in the use of subjective probabilities, and how can we think about those issues as decision analysts? What is entropy, and how can it be used in DA models?

Readings:

- J. Michael Harrison (1977). Independence and calibration in decision analysis. *Management Science*, 24, 320-328.
- \*H. V. Ravinder, Don N. Kleinmuntz, & James S. Dyer (1988). The reliability of subjective probabilities obtained through decomposition. *Management Science*, 34, 186-199.
- Thomas M. Cover & Joy A. Thomas (1991). *Elements of Information Theory*. New York: Wiley-Interscience. Excerpt from Chapter 2.

Session 7, Oct 9. Probability Models and Methods: Discrete Approximations and Copulas.

Readings:

- \*James E. Smith (1993). Moment methods for decision analysis. *Management Science*, 39, 340-358.
- Robert T. Clemen & Terence B. Reilly (1999). Correlations and copulas for decision and risk analysis. *Management Science*, 45, 208-224
- \*Kjetil Høyland & Stein W. Wallace (2001). Generating scenario trees for multistage decision problems. *Management Science*, 47, 295-307.
- Review paper: Edward W. Frees & E. A. Valdez (1998). Understanding relationships using copulas. *North American Actuarial Journal*, 2, 1–25.

Session 8, Oct 16. Expert Models. How should we use expert probability judgments in DA? How can we deal with uncalibrated judgments? What about dependence among experts?

Readings:

- Peter A. Morris (1974). Decision analysis expert use. *Management Science*, 20, 1233-1241.
- \*Robert L. Winkler (1981). Combining probability distributions from dependent information sources. *Management Science*, 27, 479-488.
- Robert T. Clemen & Kenneth C. Lichtendahl (2003). Debiassing Expert Overconfidence: A Bayesian Calibration Model. Draft.
- Review paper: Robert T. Clemen & Robert L. Winkler (1999). Combining probability distributions from experts in risk analysis. *Risk Analysis*, 19, 187-203.

Session 9, Oct 23. Multiattribute Utility I: Preference Models and Assessment. Class session led by Ralph Keeney. How can we identify the attributes of alternatives that we should consider in DA? How should we model preferences for those multiple attributes? How should we assess a multiattribute utility function?

Readings:

- *MHD*, Chapters 15-16. (Review Ch 3, pp 44-52; Ch 4, pp 137-143)
- Ralph L. Keeney & Robin S. Gregory (2003). Measuring achievement of objectives for policy decisions. Draft.
- Ralph L. Keeney (1992). *Value-focused thinking*. Cambridge, MA: Harvard University Press. Chapter 5.
- Miley W. Merkhofer & Ralph L. Keeney (1987). A multiattribute utility analysis of alternative sites for disposal of nuclear waste. *Risk Analysis* 7, 173-194.

Session 10, Oct 30. Risk Attitudes I: Basic Concepts. Class session led by Jim Smith. What is risk aversion, and why does it matter in DA? How can we assess an individual's risk-averse utility function? How can we measure risk aversion? Is it meaningful to speak of a "corporate risk attitude"?

Readings:

- *MHD*, Chapter 13
- \*John W. Pratt (1964). Risk aversion in the small and in the large. *Econometrica*, 32, 122-136.
- TBA

Session 11, Nov 6. Risk Attitudes II: Descriptive and Prescriptive Analysis. What does psychology say about how people behave when making risky choices? What implications does this have for assessing utility functions or for modeling preferences more generally?

Readings:

- *MHD*, Chapter 14
- Daniel Kahneman & Amos Tversky (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-291.  
Note: Everyone should become familiar with Kahneman & Tversky (1979), a true classic. However, you may have already read it (more than once) for other courses. If you are already very familiar with it, consider reading the follow-up: Amos Tversky & Daniel Kahneman (1992). Cumulative prospect theory: An analysis of choice under uncertainty. *Journal of Risk and Uncertainty*, 5, 297-323.

- \*Peter Wakker & Daniel Deneffe (1996). Eliciting von Neumann-Morganstern utilities when probabilities are distorted or unknown. *Management Science*, 42, 1131-1150.
- \*Han Bleichrodt, Jose Luis Pinto & Peter P. Wakker (2001). Making descriptive use of prospect theory to improve the prescriptive use of utility. *Management Science*, 47, 1498-1514.

Session 12, Nov 13. Multiattribute Utility II: Prescriptive analysis. What are issues that arise in practice when assessing multiattribute utility and value functions? What can we do about these issues?

Readings:

- \*Richard M. Anderson & Benjamin F. Hobbs (2002). Using a Bayesian approach to quantify scale compatibility bias. *Management Science*, 48, 1555-1568.
- \*Gregory W. Fischer, Nirmala Damodaran, Kathryn B. Laskey, & David Lincoln (1987). Preferences for proxy attributes. *Management Science*, 33, 198-214.
- \*Philippe Delqu   (2003). Optimal conflict in preference assessment. *Management Science*, 49, 102-115.

Session 13, Nov 20. Decision Analysis Applications. (NOTE: The articles listed below represent state-of-the-art DA practice in a variety of areas. Although we should definitely cover a couple of these, I am open to other applications that would relate more specifically to a student's area of interest (e.g., environmental decision making, public policy, medical decision making). If you would like to present an application article in your area, please see me, and we will start the process of locating a good article for the class.)

Readings:

- \*Jeffrey S. Stonebraker (2002). How Bayer makes decisions to develop new drugs. *Interfaces*, Vol. 32 (6), pp. 77-90.
- \*James S. Dyer, T. Edmunds, John C. Butler, & Jiamin Jia (1998). A multiattribute utility analysis of alternatives for the disposition of surplus weapons-grade plutonium. *Operations Research* 46, 749-762.
- \*Michael R. Walls, G. T. Morahan, & James S. Dyer (1995). Decision analysis of exploration opportunities in the onshore US at Phillips Petroleum Company. *Interfaces* 25(6) 39-56.
- Samuel E. Bodily & Michael E. Allen (1999). A dialogue process for choosing value-creating strategies. *Interfaces* 29 (6), 16-28.
- Review articles:
  - Donald L. Keefer, Craig W. Kirkwood, & James L. Corner (2004). Perspective on decision analysis applications, 1990-2001. *Decision Analysis*, 1, in press.
  - Donald L. Keefer, Craig W. Kirkwood, & James L. Corner (2003). Summary of decision analysis applications in the operations research literature, 1990-2001. Technical Report, Arizona State University.

Session 14, Dec 4. Make-up or catch-up class if needed

Friday, Dec 12. Term papers due