



DECS-433: Decision Making under Uncertainty

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Description

We all use models to arrive at decisions. These models range in sophistication from “everyone but me is a fool” to the full rationality assumed in financial markets. Unfortunately, the models we tend to use are not very good. They can, under some conditions, easily lead us astray. This would not be so terrible if these “conditions” were rare. However, they are not. This course is about how to make good models as well as how to distinguish a good model from a bad one. In the study of models and how they relate to decision making we try to find the middle ground between the perspective of the parachutist and that of the truffle hunter. We focus on evaluating uncertainty, understanding the dynamic nature of decision-making, using historical data and limited information effectively and simulating complex systems. Since the topics are quantitative in nature it may be useful to summarize and dispose of the usual objections against them.

- Objection #1: Not everything can be reduced to numbers.

True. But a great deal of importance can.

- Objection #2: Workable quantitative models cannot capture the complexities of real life.

So what? The question is not whether a particular quantitative model accurately represents reality but whether there is an alternative model that is more accurate. How do we know that a decision arrived at by what we call instinct (or intuition, experience, etc.) has really acknowledged all the complexities of reality? Indeed, one of the beauties of quantitative models is their explicitness. Like Cromwell's portrait they appear warts and all.

- Objection #3: The data requirements of quantitative models are prohibitive.

This objection had some merit 20 years ago. Given the state of modern computing, it is an excuse for laziness. One of the useful features of a quantitative model is that it tells the decision maker what information s/he should be collecting.

- Objection #4: Quantitative models ignore the context.

Yes. However, there is no law that obliges one to follow the recommendations of a quantitative model that is not appropriate to the context. Second, ignoring the context can be a good thing. Frequently, the context of a decision is irrelevant. A quantitative model often captures the essence of a decision, say, the choice between a gamble and a sure thing. It does not matter whether the context is the stock market, a medical diagnosis or wildcatting. This allows for the transfer of insight from one setting to another. An example of this is the use by hotels of the same models and principles that airlines use for yield management. A more revealing example comes from experiments on auction behavior: The subjects were managers responsible for submitting bids on construction projects. The goal was to see whether these managers made bids in accordance with the optimal bids of the standard (quantitative) auction model. As long as the auctions were couched in the context of the construction industry, the answer was yes. However, when subjects were presented with the same auction scenarios, but the context changed (for example, to oil leases) they did remarkably badly. Why? The bids they made were derived through the use of rules of thumb that were specific to their industry. When the context switched, their rules of thumb became useless. One might argue that this is not important as few people are going to switch industries mid-career. Not so. Suppose that the rules of thumb are tied to characteristics of the industry at a particular time. As time changes, those characteristics change, until eventually those rules become useless. (Note: this is also the reason for having a course not tied to a particular functional area of business).

Perhaps the most surprising thing that you will learn from this course is that simple quantitative models frequently provide profound qualitative insights into the process being modeled. Thus, one may wish to build a model not so much to decide what to do, but to test and refine one's intuition about what is going on.

Grading

There will be individual and group homework assignments (labeled accordingly). You are responsible for forming your groups, each with four people. Each group should hand in one submission for the whole group per group assignment. There will be a midterm exam that will be handed out at the end of class during week 6, and that will be due at the beginning of class during week 7. There will also be a *cumulative* final exam as per the Kellogg exam schedule. I may “cold call” students in class. Therefore, keep up with what has been going on in class and be prepared for such questions.

Your final grade will depend on

- Homework (20 %)
- Midterm (30 %)
- Final (50 %)
- Class Participation will be used at the margin.

Homework assignments should be handed in at the beginning of class on the due date. Homework solutions should be entered into the template that will be provided on *Blackboard*. Submissions that are not will be penalized. In particular, please format your responses so that the answer appears *first* and is clearly demarcated, followed by an explanation. **No late work will be accepted.** If you cannot attend class, you may email or fax your homework to me. Some homework will require you to download data files from the course homepage, which is accessible from the *Blackboard* course management system.

The final exam will take place according to Kellogg’s exam schedule and will be two hours long. Exams are individual, open-book, open-notes, and timed; computer use will be required.

Note: It is likely that I will be abroad during the week of the final (although I will be accessible via email), so plan ahead and do not leave questions to the last minute.

The syllabus is not set in stone and I reserve the right to make changes to adapt to the pace of the class. Updates will be posted on Blackboard.

Honor Code

You must follow the usual expectations created by the honor code, spelled out in http://www.kellogg.northwestern.edu/stu_aff/policies/honorcode.htm.

In addition, I would like to emphasize two points that are particularly relevant for this course:

- You are not allowed to use any material from previous offerings of this course or from other sections.
- You must have a full understanding of any homework solution you submit with your name on it. This is especially important for the group assignments.

Classroom Etiquette

You are expected to abide by the Kellogg code of classroom etiquette, available at http://www.kellogg.northwestern.edu/stu_aff/policies/etiquette.htm.

Additionally, please:

- Do not use laptops in class,
- turn off your cell phones, and
- remember to display your name-plates.

Course Outline

Part I: Probability and Biases

Week 1

Session 1: Introduction and Basic Laws of Probability

Lecture Notes:

- “*Probability Basics*,” Kellogg School of Management.

Session 2: Laws of Probability (Continued..)

Week 2

Session 3: Expectation, Variance, and Continuous Distributions

Homework 1 due.

Lecture Notes:

- “*Expectations and Variance*,” Kellogg School of Management.

Session 4: Expectation, Variance, and Continuous Distributions (Continued)

Lecture Notes:

- “*Risk*,” Kellogg School of Management.

Week 3

Session 5: Utility, VaR, Risk

Homework 2 due. The homework requires:

- “*Union Carbide-Butane Transport*,” HBS 9-180-017, 1979.

Prepare for Class Discussion:

- Al-Najjar, N.I.: “*Deal or No Deal*,” Kellogg School of Management.
- “*Value-At-Risk*,” HBS 9-297-069, 1997.

Session 6: Utility, Var, Risk

Part II: *Decision Trees, Option Value and Flexibility*

Week 4

Session 7: Decision Trees

Prepare for Class Discussion:

- “*Weston Manufacturing Company*,” HBS 9-111-047, 1967.

Homework 3 due.

Session 8: Value of Information

Prepare for Class Discussion:

- Bertsimas and Freund: “Graphics Corporation Case,” in *Data, Models and Decisions*, Dynamic Ideas, Boston, 2004.

Week 5

Session 9: Value of Information

Graphics case continued:

Session 10: Options Value and Flexibility

Prepare for Class Discussion:

- Besanko, D.: *Scrapping an Oil Tanker*, Kellogg School of Management, 2002.

Readings:

- A. Dixit and R. Pindyck: “*The options approach to capital investment*,” Harvard Business Review, 1995.

Week 6

Session 11: Market Entry with Cost Uncertainty

Homework 4 due.

Homework 5 due. This homework is to be done in groups, and consists of the following problem:

- Besanko, D.: *Exercise on Cost Uncertainty*, Kellogg School of Management.

Readings:

- T. Horn, D. Lovallo, and S. Viguerie: “*Learning to let go: Making better exit decisions*,” The McKinsey Quarterly, 2006.

Session 12: Overflow and Midterm Review

MIDTERM EXAM

Part III: *Aggregation of Risks and Information*

Week 7

Session 13: Central Limit Theorem

Prepare for Class Discussion:

- Al-Najjar, N.I.: “*Insuring Against Freak Accidents*.”

Session 14: Aggregation of Information

Homework 6 due. This homework is to be done in groups, and consists of the following problem:

- “*Wisdom of the Crowds*,” Kellogg School of Management.

Prepare for Class Discussion:

- Besanko, D.: “The Fable of ‘*The Circle of Quality Management System*,’ ” Kellogg School of Management.

Optional Reading:

- Surowiecki: *Wisdom of the Crowds*, Doubleday, 2004, Chapters 1 and 4.

Week 8

Session 15: Selection Bias

Reading:

- J. Denrell: “*Selection Bias and the Perils of Benchmarking*,” HBR, 2005.

Prepare for Class Discussion:

- Al-Najjar, N.I. and D. Besanko: “*Credit Card Solicitations*,” Kellogg School of Management, 2003.
- “*Credit Card Swipe Sears Profits*,” WSJ.

Homework 7 due. This homework is to be done in groups, and consists of the following problem:

- Al-Najjar, N.I.: “*Exercise on Informational Cascades*.”

Part IV: *Sampling*

Session 16: Confidence Intervals

Week 9

Session 17: Hypothesis Testing

Homework 8 due. This homework is to be done in groups, and consists of the following problem:

- Al-Najjar N.I.: “*Gaming Health Insurance*,” Kellogg School of Management.

Homework 9 due. The homework requires:

- “*Pilgrim Bank (A): Customer Profitability*,” HBS 9-602-104.

Session 18: Simulation *Lecture Notes:*

- “*Sampling and Simulation*,” Kellogg School of Management.

Week 10

Session 19: Simulation

Homework 10 due. This homework is to be done in groups, and consists of the following problem:

Cases:

- Bertsimas and Freund: “*Ontario Gateway Case*,” in *Data, Models and Decisions*, Dynamic Ideas, Boston, 2004.

Session 20: Course Summary and Final Exam Review

FINAL EXAM

- During exams week.