

## DECISION THEORY AND BAYESIAN STATISTICS

QA 22-480-733 Monday 6:00 – 8:40

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**OFFICE HOURS:** 4:30-5:30 Monday and Wednesday and by appointment. Office hours provide you with an opportunity for personal discussion with me concerning course-related problems such as homework, clarification of classroom discussion, test grading etc. If the formal hours are unsuitable for you, please make an appointment with me at a mutually agreeable time. I strongly urge you to take advantage of these hours.

**TESTS AND ASSIGNMENTS:** Assignments will be collected from time to time, each having a specific due-date to which you must conform. There will be no midterm exam, rather the accumulated credit on the work for the assignments will suffice to account for a large percentage of your final grade. You may form cooperative groups for solving the assigned problems. But you are urged to collaborate in a responsible manner, i.e. carrying your own weight in any cooperative arrangement. You are responsible for keeping current in the reading from the textbook. All members of a cooperative group will share the group grade. The comprehensive final will be given as scheduled by the university and will likely be a take-home exam.

**CLASS COMMUNICATION:** Every student will obtain a *Blackboard* account by going to <http://blackboard.uc.edu/> on the INTERNET. We will use Blackboard to communicate.

**CLASS NOTES:** The class notes will be made available to you in electronic format. I will post the notes on my *Blackboard* site, in .pdf format. You may read these documents by obtaining the freeware Adobe Reader. You may print out a copy of the notes if you wish. Keep in mind that the college discourages printing multiple copies of such notes in the computer labs.

**GRADING:** The accumulated assignment scores will be worth 30% of the final grade. The final exam will be worth 50% of the final grade. Exam scores will be adjusted so that a "100-90-80-70-etc." scheme for the corresponding letter grade equivalents "A-B-C-D-F" is appropriate (I do not exercise the "+ and -" option). A class project will be worth 10% of the final grade. The remaining 10% will be based upon any other assignments that may be collected and other "intangible" sources that reflect "attitude" such as class participation and my personal impressions.

**MISCELLANEOUS:** The grade of "Incomplete" will be given only for fully documented medical conditions or other catastrophes as judged by me. You may drop the course without penalty up to the Friday of the eighth week of class. No special exams or assignments will be given a quarter's end for grade improvement. Students are responsible for all material, assignments and announcements made in class whether or not they attended the class. All exams must be strictly personal efforts, unless I announce that exams may be a team effort. No collaboration is permitted

on take-home exams either, with the same exception as above. You are expected to bring a working hand-held calculator if we will have an in-class exams. Where required, all work must be shown. No work=no credit. Solely I will determine partial credit. Of course you may discuss the basis of your grade with me but this discussion must take place in private and not in open class. Keep all graded exams and assignments. The final exam will remain in my possession for two quarters. I regard a student's attitude and interest to be a very important component in evaluation and I reserve the right to raise a grade based upon my impression. You are strongly urged to suggest any improvements in the teaching or classroom procedure. In case a notice of class cancellation is posted, you must remain in class for a period of ten minutes to confirm the validity of that notice.

**TEXTS:** The main text will be Statistical Decision Theory and Bayesian Analysis, 2nd Ed., by James O. Berger. We will cover various portions of the first four chapters. An additional text Decision Analysis: Introductory Lectures on Choice Under Uncertainty, by Howard Raiffa is assigned reading for a project. I will announce the availability of the text on the first day of class.

**PREREQUISITES:** Students need to have knowledge of calculus, knowledge of probability (at the level of QA 844 or its equivalent), and knowledge of statistical methodology. Exposure to principles of statistical inference (as covered in QA 891) is very helpful, but not mandatory.

**AIMS AND OUTLINE:** The syllabus emphasizes the applied aspects of statistical decision theory and Bayesian analysis and we will follow the outline for an applied course as described in the preface of the main text. The topics to be covered should appeal to students of applied statistics, especially those in business, economics, engineering, the social sciences, and the life sciences. The goals of this course are as follows:

1. To introduce the students to the terminology, applications, and some foundational ideas in decision theory and Bayesian statistics.
2. To expose the students to the following concepts during the course:
  - a. Game theory approach to decision analysis
  - b. Expected loss, decision rules and risk
  - c. Decision principles
  - d. Utility functions and loss functions
  - e. Prior information and subjective probability
  - f. Bayesian statistical inference including: point estimation, interval estimation, hypothesis testing, and prediction, all from a Bayesian point of view.
  - g. Bayesian decision theory
3. To make the students aware of the differences between the frequentist and Bayesian philosophy and the controversy surrounding the Bayesian paradigm of inference.
4. To provide enough rigor in the development of these topics so that the students will be able to amend or extend procedures when necessary and to read advanced works on the subject.
5. To enable the students to apply decision theoretic and Bayesian techniques in solving decision problems.

6. To provide a sufficiently mathematical treatment that will enable the students to pursue more advanced study in the statistical area of decision theory and Bayesian analysis.

Achievement of these goals should enable the student to:

1. Communicate effectively with others concerning the use and interpretation of decision theoretic and Bayesian statistical tools.
2. Better understand reports, research, etc., that make use of decision theoretic and Bayesian statistical tools.
3. Identify potential uses of decision theoretic and Bayesian methodology and to conduct appropriate analyses in such cases.
4. Pursue further study in decision theory and Bayesian analysis.

**PROJECT:** Each student is required to read approximately 30 to 35 pages per week in the supplemental text by Raiffa. This is an excellent nonmathematical discussion of the decision theoretic approach to solving decision problems and provides a strong defense of the proposition that a 'good decision maker' must be a Bayesian decision maker. Individually or in groups, carry out and neatly write up the solutions required to the decision problem in the sections entitled 'PROJECT' on pages 34, 47, 100, and 156. This is to be submitted on the day of the final exam for evaluation. I encourage you to work in groups. All students participating in a group will be given the group grade for the project. Participants in a group will be responsible for 'policing' the quality of their colleague's contribution to the successful completion of the project. The project is an exercise in an elementary, yet powerful methodology employing decision trees. You may use PROC DTREE on SAS to carry out the steps for solving the Oil Wildcatter decision problem. I am assigning the reading of the documentation on how to use this SAS procedure as an independent task. You can read all about SAS and in particular PROC DTREE by visiting the *SAS ONLINE Version 8.2* URL <http://www.uc.edu/sashtml>. Ironically, the example SAS uses to illustrate the features of PROC DTREE correspond in part to the same decision problem I have assigned to you. If you do not want to use SAS, that is fine too. Just carry out the assignment by hand. Personally, I think you ought to use SAS.