GEORGETOWN UNIVERSITY

SCHOOL OF BUSINESS ADMINISTRATION

SPRING 2000

DSCI-563-20
APPLIED DECISION THEORY

Techniques for Decision Making Advanced Quantitative Methods

Professor José-Luis Guerrero-Cusumano

guerrerj@gunet.georgetown.edu

Telephone; 202-687.4338

Meeting Times: T 04:15 PM- 06:45PM
HEA 103

Suggested Office Hours:
T and R 3:00 PM- 4:00 P.M

February 22 Cases 2 and 5 due
February 29 Case 6 and Take-home Final due.

Techniques for Decision Making

Suppose you have been give the responsibility of determining whether your firm should expand its sales region to include the southwestern part of the United States or India. Before making your decision, you would probably want answers to many questions. How large would the yearly demand for the product be? How many salespeople would be assigned to the new territory? How much and what types of advertising would be used? Even if it were possible to obtain accurate answers (perfect information) to these and other pertinent questions, your decisions problem would be extremely complex and realistically you cannot expect to receive perfect information. Thus, in making your decision, you will face the more complex problem of having to deal with answer about which you are uncertain.

The ***first part of this course*** will be based on the chi-square test, analysis of Contingency tables and non-parametric statistics. These methodologies will help to create an additional set of quantitative approaches for a particular problem and the development of an appropriate methodology for its testing. At the end of the course, concepts of Design of Experiments, analysis of variance will be developed.

This is an applied course, i.e. cases and exercises of different areas of business will be considered.

The ***second part of the course*** will center on Decision Analysis. Decision Analysis is a systematic approach to solving problems under conditions of uncertainty. It does not describe how or why individual makes a decision; rather, it prescribes a decision for the individual that is consistent with his/her preferences and attitudes towards risk. One of the alternatives we face in making a decision is whether the decision should be made now-utilizing information that we clearly possess about the problem or postponed until we have gathered additional information.

Any decision making process can be described as comprising seven basic elements: 1) defining the problem/setting goal, 2) identifying alternative solutions, 3) assessing the pros and cons (costs and benefits) of the more attractive alternatives, 4) applying the criteria for selection, 5) selecting the preferred course of action, 6) implementing the decision, adjusting as necessary and 7)

monitoring results and revising as necessary.

These situations require different quantitative methodologies. A good decision is based on a solid methodology.

Textbooks Recommended:

1) McClave, J., Benson, P.G. and Sincich, T. Statistics for Business and Economics, 7th edition, Prentice-Hall. (same book as in quantitative I and II), Chapters 15 through 18 will be studied.

2) Class Notes

Suggested Readings:

1) Baird, B.F. Introduction to Decision Analysis, 1998

2) Box. G.E., Hunter, W.G. Hunter, Statistical for Experimenters

3) Brown, R. V., Kahr, A.S. Decision Analysis for Managers.

4) LaValle, I Fundamentals of Decision Analysis, 1998

GRADES DIVISIONS:

Class Participation and Minicases (Cases 2 -5-6 —team projects)	**36%**
In-class Hourly Exam	**34%**
Comprehensive Final Exam -take-home	**30%** .

Topics:

Helping the Decision Process: Testing a Complex Hypothesis

CHAPTER 17: THE CHI-SQUARE TEST AND THE ANALYSIS OF CONTIGENCY TABLES

- II) The Chi-square Test and Analysis of Contingency
- .1) One-Dimensional Count Data: Multinomial Distribution
- .2) Contingency Tables

Helping the Decision Process: When Nothing Works and your Assumption are wrong:

CHAPTER 16: NON-PARAMETRIC STATISTICS

- III) Non-parametric Statistics
- .1) Single Population Inferences
- .2) Comparing two Populations
- .3) Paired Differences
- .4) Correlation for Rank Data.

Helping the Decision Process: An Introduction to Minimizing Variability

CHAPTER 15: DESIGN OF EXPERIMENTS AND ANALYSIS OF VARIANCE (introduction)

- IV) Design of Experiment and Analysis of Variance
- .1) Elements of a Designed Experiment
- .2) The Completely Randomized Design: Single Factor
- .3) Factorial Experiments

How to Make Decisions given imperfect Information:

CHAPTER 18: DECISION ANALYSIS

1) Elements of a Decision Analysis
The Precision Tree Add-In. Introduction to Influence Diagrams. More Single-Stage Examples. Multistage Decision Problems. Decision and Probability Trees. Basic Ideas of Game Theory.

2) Decision making under Certainty

3) Decision Making under Uncertainty
Solving decision problems using expected pay-off criteria. Revising State of Nature Probability: Bayes' Rule / Incorporating Attitudes Toward Risk

4) The expected Utility Criterion
Classifying Decision-Makers by their utility functions.

5) Solving Decision Problems using Posterior Probabilities

6) The Expected Value of Perfect Information.

7) The expected Value of Sample Information: Preposterior analysis.

	Topics	***Suggestion: Solve all the supplementary Exercises for Each Chapter.*** Chapters
January 18	Chi-Square	17
January 25	Chi-Square/ Nonparametric	17/16
February 1	Nonparametric/ Design of Experiment	16/15
February 8	Design of Experiment	15
February 15	First Hourly Decision Analysis	18
February 22	Decision Analysis	18-Cases 2 and 5 due
February 29		Case 6 and Take-home Final

MINITAB-Nonparametic Analysis Overview

Minitab provides the following types of nonparametric procedures:

- tests of the population location (sign test, Wilcoxon test, Mann-Whitney test, Kruskal-Wallis test, Mood's median test, and Friedman test)
- a test of randomness (runs test)
- procedures for calculating pairwise statistics (pairwise averages, pairwise differences, and pairwise slopes)

Parametric implies that a distribution is assumed for the population. Often, an assumption is made when performing a hypothesis test that the data are a sample from a certain distribution, commonly the normal distribution. Nonparametric implies that there is no assumption of a specific distribution for the population.

An advantage of a parametric test is that if the assumptions hold, the power, or the probability of rejecting H0 when it is false, is higher than is the power of a corresponding nonparametric test with equal sample sizes. An advantage of nonparametric tests is that the test results are more robust against violation of the assumptions. Therefore, if assumptions are violated for a test based upon a parametric model, the conclusions based on parametric test p-values may be more misleading than conclusions based upon nonparametric test p-values. See [1] for comparing the power of some of these nonparametric tests to their parametric equivalent.

Tests of population location

These nonparametric tests are analogous to the parametric t-tests and analysis of variance procedures in that they are used to perform tests about population location or center value. The center value is the mean for parametric tests and the median for nonparametric tests.

- 1-Sample Sign performs a one-sample sign test of the median and calculates the corresponding point estimate and confidence interval. Use this test as a nonparametric alternative to *one-sample Z and one-sample t-tests*.
- 1-Sample Wilcoxon performs a one-sample Wilcoxon signed rank test of the median and calculates the corresponding point estimate and confidence interval. Use this test as a nonparametric alternative to *one-sample Z and one-sample t-tests.*
- Mann-Whitney performs a hypothesis test of the equality of two population medians and calculates the corresponding point estimate and confidence interval. Use this test as a nonparametric alternative to the *two-sample t-test.*
- Kruskal-Wallis performs a hypothesis test of the equality of population medians for a one-way design (two or more populations). This test is a generalization of the procedure used by the Mann-Whitney test and, like Mood's median test, offers a nonparametric alternative to the *one-way analysis of variance.* The Kruskal-Wallis test looks for differences among the populations medians.

The Kruskal-Wallis test is more powerful (the confidence interval is narrower, on average) than Mood's median ***test for analyzing data from many distributions, including data from the normal distribution, but is less robust against outliers.***

- Mood's Median Test performs a hypothesis test of the equality of population medians in a one-way design. Mood's median test, like the Kruskal-Wallis test, provides a nonparametric alternative to the usual one-way analysis of variance. Mood's median test is sometimes called a median test or sign scores test.

Mood's median test is robust against outliers and errors in data, and is particularly appropriate in the preliminary stages of analysis. Mood's median test is more robust against outliers than the Kruskal-Wallis test, but is less powerful (the confidence interval is wider, on the average) for analyzing data from many distributions, including data from the normal distribution.

- Friedman performs a nonparametric analysis of a randomized block experiment and thus provides an alternative to the two-way analysis of variance.

Randomized block experiments are a generalization of paired experiments. ***The Friedman test is a generalization of the paired sign test with a null hypothesis of treatments having no effect. This test requires exactly one observation per treatment-block combination.***

Tests for randomness

Runs Tests test whether or not the data order is random. No assumptions are made about population distribution parameters. Use Stat > Quality Tools > Run Chart to generate a run chart and perform additional tests for randomness.

Procedures for calculating pairwise statistics

Pairwise Averages, Pairwise Differences, and Pairwise Slopes compute averages, differences, and slopes, respectively, for all possible pairs of values. These statistics are sometimes used in nonparametric statistical calculations.

BIBLIOGRAPHY:

[1] Gibbons, J.D. (1976). Nonparametric Methods for Quantitative Analysis. Holt, Rhinehart, and Winston.

[2] T.P. Hettmansperger and S.J. Sheather (1986). "Confidence Intervals Based on Interpolated Order Statistics," Statistics and Probability Letters, 4, pp.75–79.

[3] M. Hollander and D.A. Wolfe (1973). Nonparametric Statistical Methods, John Wiley & Sons.

[4] D.B. Johnson and T. Mizoguchi (1978). "Selecting the Kth Element in X + Y and X1 + X2 + … + Xm," SIAM Journal of Computing 7, pp.147–153.

[5] E.L. Lehmann (1975). Nonparametrics: Statistical Methods Based on Ranks, Holden–Day.

[6] J.W. McKean and T.A. Ryan, Jr. (1977). "An Algorithm for Obtaining Confidence Intervals and Point Estimates Based on Ranks in the Two Sample Location Problem," Transactions on Mathematical Software, pp.183–185.

[7] G. Noether (1971). Statistics—A Non–Parametric Approach, Houghton-Mifflin.

Discussion Minicases

DSCI-563-20 Spring 2000

APPLIED DECISION THEORY

Prepared by

Professor Jose Luis Guerrero Cusumano

Based on cases discussed in
Statistics for Management and Economics
G. Keller, B. Warrack and H.Bartel
3rd Edition, 1994, Ed. Duxbury

CHAPTER 17
CASE 1: Auditor Switching in Failing Companies

The phenomenon of auditor switching has broad implications for the auditing profession, and the Securities and Exchange Commission has expressed its concern over this issue (see, for example, SEC ASR No. 165 [1974]). There may be a variety of reasons behind any switch in auditor. In a study designed to examine the issue, the following factors were hypothesized to influence auditor switching:

- The financial health of the company
- The desire for a more prestigious auditor when the company is failing
- Receipt of qualified opinion from the current auditor in a failing company
- A change in company management in a failing company

The experiment consisted of examining a random sample of 132 companies that went bankrupt in the period from 1974 to 1982 and another 132 similar, but financially healthy, companies. Each company was asked if it had switched CPA firms and (if so) whether the switch involved a Big Eight CPA firm, whether its audit statements were qualified, and whether the firm changed management. The results are laid out in the Tables A-D.

Comment on the factors that influence an auditor switch.

TABLE A Association Between Financial Distress and Auditor Switches

Action Taken	Bankrupt	Nonbankrupt
Switched CPA firms	35	13
Did not switch CPA firms	97	119

TABLE B Direction of Auditor Switches by Failing Companies

Action Taken	Switched to Big Eight CPA Firm	Switched to Non-Big Eight CPA Firm

Switched from Big Eight CPA Firm	11	10
Switched from Non-Big Eight CPA Firm	12	2

TABLE C Association Between Audit Qualification and Auditor Switches for Failing Companies

Action Taken	Qualified	Not Qualified
Switched CPA firms	14	17
Did not switch CPA firms	63	34

TABLE D Association Between Management Changes and Auditor Switches for Failing Companies

Action Taken	Changed Management	Did Not Change Management
Switched CPA firms	13	18
Did not switch CPA firms	34	63

CHAPTER 17

Case 2:Can Exposure to a Code of Professional Ethics Help Make Managers More Ethical?

Note: The data are found in the share drive.

In many North American business schools, the issue of a whether a course on ethics should be compulsory has been hotly debated. The empirical evidence appears to be far from consistent on the effects of such courses. To help shed more light on the issue, two researchers organized a study in which they took a random sample of 68 accounting students and 132 nonaccounting business students. As part of their curriculum, the accounting students were exposed to the American Institute of Certified Public Accountants' code of professional ethics. The nonaccounting business students did not take any course that dealt with issues of ethical behavior.

All 200 students in the study were taking a required senior-level policy course. As part of the course, they were assigned to read the article "Crisis in Conscience at Quasar" by Fendrock (*Harvard Business Review*, March-April 1968, pp. 112-20. In the case, Universal, the parent company, has learned that the senior managers of one of its subsidiaries, Quasar, have deliberately lied about financial conditions in their monthly report to corporate headquarters. Quasar's president, John Kane, and its controller, Hugh Kay, have been forced to resign. Universal would like to know why no one at Quasar provided any information about the true financial conditions, if any other executives were accomplices to the phony reports, and what can be done to avert such occurrences in the future. Universal sent a fact-finder to interview other executives at Quasar - George Kessler, vice-president, manufacturing; William Heller, vice-president, engineering; Peter Loomis, vice-president, marketing; Donald Morgan, chief accountant; and Paul Brown, vice-president, industrial relations.

After studying the case, students completed the questionnaire shown below. (The responses to questions 1 to 10 for all students are stored in columns 1 to 10; column 11 indicates whether the student was an accounting student [1] or a nonaccounting business student [2].) Does it appear that accounting students exposed to a code of ethics answer the questionnaire differently from nonaccounting business students no exposed to the same code?

QUASAR QUESTIONNAIRE

1. If you have been John Kane, president of Quasar, do you think you would have been tempted to withhold the bad news from corporate management at the parent company?

   1. Yes _____ 0. No

2. Do you think that under the circumstances you would have withheld the bad news?

   1. Yes _____ 0. No

3. If you were in the position of Loomis, Kessler, or Heller, would you have felt that your loyalty to the president of Quasar transcended your loyalty to the total company?

   1. Yes _____ 0. No

4. Do you think you would have gone around the president and reported the bad news to corporate headquarters at Universal?

   1. Yes _____ 0. No

5. Do you think corporate management was right to request the resignation of Quasar's president?

   1. Yes _____ 0. No

6. Do you think corporate management was right to request the resignation of Quasar's controller?

   1. Yes _____ 0. No

7. Do you feel that a subsidiary's executives (other than the president) should communicate directly with corporate management of the parent as a regular procedure?

   1. Yes _____ 0. No

8. Do you think Kane's withholding the bad news was (check just one)?

   1. Practical
   2. Unethical
   3. Poor judgment

9. Do you think the major blames lies with (check just one)?

   1. Universal's corporate management
   2. Quasar's president
   3. Quasar's controller
   4. Other

10. Is the problem one of (check just one)?
   1. Poor organization
   2. Lack of Communication
   3. Excessive Personal Loyalty
   4. Inadequate supervision
   5. Other

CHAPTER 17

CASE 3:Stock Return Distributions

When investors purchase common stock, the rate of return that they realize over the forthcoming period (which could be taken as a day, a week, a month, or a year) is a continuous random variable. Investors might, for example, enjoy a 20% return (a gain) or suffer a -10% return (a loss). Since the beginning of the century, numerous students of the stock market have hypothesized that distributions of stock returns are approximately normal.

In two well-known studies of stock price behavior, Eugene Fama observed both the daily returns and the monthly returns for the 30 stocks in the Dow Jones Industrial Average (DJIA) over a 5-year period. Fama's results are summarized in Tables A and B, which show the average percentages of returns (over the 30 stocks) that fell into various intervals. For example, 46.7% of the daily returns were within .5 standard deviations of the mean daily return.

TABLE A Average Relative Frequency of 1,200 Daily Returns of DJIA Common Stocks

Intervals In Terms of Standardized *z*-Values	Percentage of Observed Daily Returns
Less than -2.0	2.1%
-2.0 to -1.5	3.1
-1.5 to -1.0	7.4
-1.0 to -.5	14.4
-.5 to .5	46.7
.5 to 1.0	13.6
1.0 to 1.5	6.4
1.5 to 2.0	3.2
Greater than 2.0	3.1

TABLE B Average Relative Frequency of 200 Monthly Returns of DJIA Common Stocks

Intervals In Terms of Standardized *z*-Values	Percentage of Observed Monthly Returns
Less than -2.0	1.6%
-2.0 to -1.5	3.7
-1.5 to -1.0	9.3
-1.0 to -.5	15.9
-.5 to .5	40.1
.5 to 1.0	14.7
1.0 to 1.5	8.0
1.5 to 2.0	3.9
Greater than 2.0	2.8

Fisher and Lorie later observed the returns over a 1-year period on approximately 32,000 portfolios. Each portfolio consisted of eight stocks randomly selected from those listed on the New York Stock Exchange. (The authors noted that the total number of portfolios consisting of eight stocks that could be selected from 1,000 stocks is about 2.4×10^{19}.) Various percentiles of the distribution of returns observed on these portfolios are shown in Table C, together with the mean and the standard deviation of the observed returns.

What would you conclude about the normality of stock returns? Answer the question both from a visual inspection of the relevant histograms and after concluding the appropriate statistical tests.

TABLE C Distribution of 32,000 Observed Returns on Portfolios of Eight Stocks

PERCENTILE	RETURN
5th	8.1%
10th	11.7
20th	16.3
30th	20.0
40th	23.2
50th	26.4
60th	29.9
70th	33.8
80th	38.9

90th	46.7
95th	54.3
Mean	28.2
Standard deviation	14.4

CHAPTER 16

CASE 4:Capitalization Ratios in the United States and Japan

Note: The data are found in the share drive.

Firms raise funds to finance their operations by issuing debt to lenders and by issuing equity to shareholders. If the amount of debt employed by a firm is relative to the amount of equity, the firm is said to have a high degree of financial leverage. One measure of a firm's leverage is its *capitalization ratio* - the ratio of the value of a firm's equity to the total value of its equity plus debt. The smaller firm's capitalization ratio is, the more highly leveraged the firm is. The size of the capitalization ratio, however, depends on whether is computation is based on the (accounting) book value of equity or the market value of equity.

In a study comparing the leverage of American and Japanese firms, Michel and Shaked computed the capitalization ratios for a sample of American firms and for a sample of Japanese firms, using both book values and market values of equity. As expected, they observed that the shapes of the distributions of capitalization ratios differed between American and Japanese firms. For example, the distribution of book value-based capitalization ratios was reasonably symmetrical for American firms, while the corresponding distribution for Japanese firms exhibited considerable negative skewness. Michel and Shaked were primarily interested in testing "the commonly held belief among Japanese businessmen, Japanese government officials, and the investment community worldwide that Japanese firms on average are more highly leveraged than their American counterparts."

From each of 10 industries, Michel and Shaked selected a sample of 13 American firms and 13 Japanese firms. The average book value-based capitalization ratio that were computed for each of the 10 industries, for 1981, are shown in Table A. Table B presents similar information, using market value-based capitalization ratios. What would you conclude from a comparison of these ratios?

The data are stored in the first four columns of file case.

TABLE A Book Value-Based Capitalization Ratios

INDUSTRY	U.S.A.	JAPAN
1	.582	.484
2	.597	.435
3	.485	.435
4	.476	.393
5	.435	.353
6	.483	.288
7	.428	.288
8	.392	.182
9	.433	.174
10	.400	.140

TABLE B Market Value-Based Capitalization Ratios

INDUSTRY	U.S.A.	JAPAN
1	.734	.654
2	.625	.662
3	.452	.662
4	.499	.546
5	.414	.495
6	.458	.390
7	.372	.390
8	.388	.262
9	.438	.252
10	.275	.226

CHAPTER 16
CASE 5:Effects of Gender on Worker Evaluations

Note: The data are found in the share drive.

Are there differences in the way that female and male workers and their supervisors evaluate their performance on the job? Some research seems to indicate that the gender of supervisors and their subordinates may affect levels of agreement between supervisors' evaluation of employees and the employees' evaluation of themselves. It is believed that men rate their performance more favorably than women rate theirs, and women tend to rate others more favorably than men do. Two researchers investigated these beliefs in an actual work setting. The researchers had four hypotheses to test.

1. Female subordinates rate themselves lower than their supervisors rate them. Male subordinates rate themselves higher than their supervisors rate them.

2. Female subordinates rate themselves lower than male subordinates rate themselves.

3. Female supervisors rate subordinates higher than subordinates rate themselves. Male supervisors rate subordinates lower then subordinates rate themselves.

4. Female supervisors rate subordinates higher than male supervisors rate subordinates.

The study involved assemblers and their supervisors in an electronics manufacturing plant. There were 16 male and 19 female supervisors. Researchers randomly chose 1 male and 1 female assembler working under each of the 35 supervisors. The assemblers were asked to rate their own performance while the supervisors rated each of their subordinates' performance. The ratings were based on a 5-point scale where 1 = "performance is below the minimum acceptable level" and 5 = "performance consistently far exceeds expectations."

The results are stored in share drive using the following format.

Column 1: Ratings of all 35 supervisors of their male

subordinates.

Column 2: Ratings of male subordinates of themselves.

Column 3: Ratings of all 35 supervisors of their female subordinates.

Column 4: Ratings of female subordinates of themselves.

Column 5: Index indicating male or female supervisor; 1 = male and 2 = female.

What conclusions can be drawn from these data?

CHAPTER 18
CASE 6: DECISION THEORY

A factory produces a small but important component used in computers. The factory manufacturers the component in 1000-unit lots. Because of the relative advanced technology, the manufacturing process results in a large proportion of defective units.

In fact, the quality control engineer has observed that the percentage of defective units per lot has been either 15% or 35%.
In the past year, 60% of the lots have had 15% defectives and 40% have had 35% defectives. The present policy of the company is to send the lot to the customer, replace all defectives, and pay any additional costs.

The total cost of replacing a defective unit that has been sent to the customer is $10/unit. Because of the high costs, the company management is considering inspecting all units and replacing the defective units before shipment. The sampling cost is $2/unit, and the replacement cost is $0.50/unit. Each unit sells for $5.

Questions:

1) Based on the history of the past year, should the company adopt the 100% inspection plan

2) Is it worthwhile to take a sample of size 2 from the lot before deciding whether to inspect 100%?

Some Hints:
You may need to use the binomial tables or compute binomial probabilities.