PEPPERDINE UNIVERSITY

THE PEPPERDINE GRAZIADIO
BUSINESS SCHOOL

DESC 637.25FL

Multiple Attribute Decision Analysis

SYLLABUS

DESC 637: Multiple Attribute Decision Analysis

Course Description

One of the major classes of problems in the field of decision analysis is one-time decisions where a group of alternatives must be compared based on multiple (and possibly competing) goals and objectives. This type of problem, called a multiattribute decision, is found in many resource-allocation and policy-making applications. As leaders in business increasingly consider the social and environmental consequences of their firms' actions, the ability to solve multiattribute decision problems is becoming progressively more important. There are also many personal decision-making problems that involve multiple attributes (both quantitative and qualitative), such as choosing a job or purchasing a home. The challenge in this type of decision is to create a "value model" that allows explicit comparisons between alternatives that often differ in many ways.

The study of these types of decisions is based on multiattribute utility theory (MAUT), which is an extension of the fundamental axioms of decision analysis. MAUT provides a framework for quantitative models that utilize a multidimensional utility function to compute an alternative's overall desirability based on how it performs on a set of evaluation measures. In this approach, we make a clear distinction between the choices that can be made (the alternatives), the characteristics of the alternatives (quantified by the measures), and the relative desirability of different sets of characteristics (preferences). These distinctions allow the clear separation of the objective and subjective parts of a decision. The basic methodology for multiobjective problems, which is typically supported with a spreadsheet model or software application, consists of the following steps:

1. Identify the alternatives to be ranked.
2. Clarify the goals and objectives that should be met by choosing the top-ranking alternative.
3. Identify measures to quantify how well the alternatives meet the goals and objectives.
4. Quantify the level for each measure for each alternative.
5. Quantify preferences about different levels of the measures.
6. Rank the alternatives by combining information from Steps 4 and 5.
7. Do "sensitivity analysis" to see the effects on the results of changes in measure levels or preferences.
8. Be able to use software to make a model.
9. Identify the role of a decision model in a decision-support systems (DSS).

In this class, we will first briefly review the axioms of decision analysis and present the theory of multiattribute utility. We will then develop a methodology for implementing this theory to solve multiobjective problems and demonstrate the application to several real-world applications, ranging from simple personal decisions, to strategic decisions for large firms. Two of the examples we will consider are a case of resource allocation in an R&D organization where the value of individual projects is not well known and resource

allocation and portfolio management in a nonprofit firm, where the decision criteria include welfare defined across a broad group of potential stakeholders, "competitive" strategy with others in the nonprofit space, donor/sponsor support, charter/social agenda, and many others.

Mission

This course explores the role of the values-centered leader in decision-making and includes aspects of social, ethical, and environmental stewardship in establishing the optimal decision policies for a firm. In addition, this course advances the Graziadio School's mission of including applied research topics in the education of its graduate business students.

Textbook and Course Materials

The primary textbook is: Clemen, R., & Reilly, T. (2004). *Making hard decisions*. Mason, OH: South-Western, ISBN# 0495015083 (ISBN-13# 978-0495015086). There will also be supplemental readings handed out in class and from the *Logical Decisions Software User Manual*.

Grading

Item	Rubrics	Percent of Grade	Additional Notes
Participation/ Engagement	This is a group item. • Presentation of the case • Answering case questions • Commenting on other groups' discussion	10%	We will form groups for this course. Each group then is assigned to present a case or a problem every week. Each member should participate in the presentation. The presentations, in addition to engagement in terms of asking questions or participating in other groups' discussion, will form this portion of grading. For this part, groups DO NOT need to make slides, just orally discuss the case.
Quizzes (on face-to-face sessions)	Quizzes will be on an individual basis and will be administrated in face-to-face sessions.	30%	
Final Project Report and Presentation	This is a group item. • Presentation of the end of the class	15%	The first draft of your work should be prepared by the final face-to-face session of the class.

	case • How well the report is written, both in the sense of a technical report and in the sense of encompassing different aspects of the class • How well the slides are prepared		The presentation is from the project that each group has developed throughout the course. The report should be comprehensive and discuss different criteria and measures that we learned in this course. Each group needs to submit one series of presentation slides and one report.
Homework	Refer to weekly homework assignments.	20%	Refer to the schedule.
Final exam		20%	
Presence and Administrative Review	This part is mainly gauging your presence during the class and different sessions. You will lose points if you show up late or do not have presence of mind during the class. An on-time student who actively engages in the class will get all the points in this section.	5%	Participation is expected and is critical to your success. This is a very subjective grade and will consist of my perception of your preparedness for class, your ability and willingness to communicate your ideas as well as respond to others, and your attitude during class sessions. In addition, we will be evaluating your attitude in terms of maturity, accountability, and professionalism. Each learning module is generally assessed as described below using your social media participation in VoiceThread. In addition, your participation in the real-time weekly events will be a part of the participation grade.

Grading Scale

Min.	Max.	Letter Grade		Grade Point
95	100	A		4.0
90	94.99	A–	3.7	
88	89.99	B+	3.3	
85	87.99	B		3.0
80	84.99	B–	2.7	
78	79.99	C+	2.3	
75	77.99	C		2.0
70	74.99	C–	1.7	

Course Computing:

The software used in this class is the academic version of Logical Decisions, which will be available for purchase through the website (www.logicaldecisions.com) at student pricing. We will be working through examples using this software during classes, so students are encouraged to bring their notebook computers to follow along.

University Code of Ethics

Please see the *Academic Catalog:*
http://catalog.bschool.pepperdine.edu/content.php?catoid=3&navoid=113&hl="code+of+ethics"&returnto=search - University_Code_of_Ethics

Originality of Work

This course may require electronic submission of essays, papers, or other written projects through the plagiarism-detection service Turnitin (http://www.turnitin.com). Turnitin is an online plagiarism-detection service that conducts textual similarity reviews of submitted papers. When papers are submitted to Turnitin, the service will retain a copy of the submitted work in the Turnitin database for the sole purpose of detecting plagiarism in future submitted works. Students retain copyright on their original course work. The use of Turnitin is subject to the Terms of Use agreement posted on Turnitin.com. You may request, in writing, to not have your papers submitted through Turnitin. If you choose to opt out of the Turnitin submission process, you will need to provide additional research documentation and attach additional materials (to be clarified by the instructor) to help the instructor assess the originality of your work.

Policy on Disabilities

Office of Student Accessibility

The Office of Student Accessibility (OSA) offers a variety of services and accommodations to students with disabilities based on appropriate documentation, nature of disability, and academic need. It is your responsibility to notify the professor of any disabilities; I would be glad to work with you to make this a safe learning environment for you. To initiate services, students should contact the OSA director at the beginning of the semester to discuss reasonable accommodation. If a student does not request

accommodation or provide documentation, the faculty member is under no obligation to provide accommodations. You may contact the director of OSA at (310) 506-6500. For further information, visit the OSA website at https://www.pepperdine.edu/student-accessibility/.

Conduct

The University expects from all of its students and employees the highest standard of moral and ethical behavior in harmony with its Christian philosophy and purposes. Engaging in or promoting conduct or lifestyles inconsistent with traditional Christian values is not acceptable.

The following regulations apply to any person, graduate or undergraduate, who is enrolled as a Pepperdine University student. These rules are not to be interpreted as all-inclusive as to situations in which discipline will be invoked. They are illustrative, and the University reserves the right to take disciplinary action in appropriate circumstances not set out in this catalog. It is understood that each student who enrolls at Pepperdine University will assume the responsibilities involved by adhering to the regulations of the University. Students are expected to respect order, morality, personal honor, and the rights and property of others at all times. Examples of improper conduct for which students are subject to discipline are as follows:

- Dishonesty in any form, including plagiarism, illegal copying of software, and knowingly furnishing false information to the University
- Forgery, alteration, or misuse of University documents, records, or identification
- Failure to comply with written or verbal directives of duly authorized University officials who are acting in the performance of assigned duties
- Interference with the academic or administrative process of the University or any of the approved activities
- Otherwise unprotected behavior that disrupts the classroom environment
- Theft or damage to property
- Violation of civil or criminal codes of local, state, or federal governments
- Unauthorized use of or entry into University facilities
- Violation of any stated policies or regulations governing student relationships to the University

Disciplinary action may involve, but is not limited to, one or a combination of the alternatives listed below:

Dismissal: separation of the student from the University on a permanent basis.
Suspension: separation of the student from the University for a specified length of time.
Probation: status of the student indicating that the relationship with the University is tenuous and that the student's records will be reviewed periodically to determine suitability to remain enrolled. Specific limitations to and restrictions of the student's privileges may accompany probation.

Attendance Policy

Students are responsible for all synchronous or asynchronous instruction. Live (synchronous) sessions are required instructional elements of every online class, and real-time attendance and engagement is expected of students on a consistent basis. To ensure the fulfillment of all course objectives and deliverables, faculty may require attendance at certain live sessions without exception. In cases where an absence from a session has been approved by the instructor, the student will be assigned work to demonstrate mastery of the required content. Failure to complete this work will impact a student's grade.

SCHEDULE

Week	Topic	Reading*	Assignments
Week 1	Introductions to Multiattribute Decision Theory, Structuring Decisions, Defining Objectives, Attributes, and Preferences	C&R, pp. 1–12 C&R, pp. 43–68 C&R, pp. 79–83 LD, Chapters 3 and 4	Discussions and Homework 1
Week 2	Optimization Models: Linear Programming		Discussions and Homework 2
Week 3	Analysis of Multiattribute Problems With Decision Trees, Probabilistic Inputs	C&R, pp. 133–145 C&R, pp. 154–159 LD, Chapter 5	Discussions and Homework 3
Week 4	Expected Utility Theory, Risk Theory, Utility Assessment	C&R, pp. 527–546 LD, Chapter 6	Discussions and Homework 4
Week 5	Risk Attitudes		Discussions and Homework 5
Week 6	Utility Axioms and Paradoxes, Preference Assessment	C&R, pp. 571–594 LD, Chapter 7	Discussions and Homework 6
Week 7	Advanced Issues in Multiattribute Decision-Making, Aggregation of Individual Preferences, Group Decisions	C&R, pp. 598–629 C&R, pp. 644–667 LD, Chapter 9, pp. 55–64 Handout	Discussions and Homework 7
Week 8	Final Project and Final Exam		

* CR: Clemen and Reilly's *Making Hard Decisions*; LD: *Logical Decisions User Manual*

Summary of Directed Instruction Elements

Please note, at the Graziadio School of Business, directed instruction is driven by instructional design principles aligned with the School and University mission. In this regard, they are formative (not summative) and represent the personalized nature of the education offered. All courses must include a minimum of 15 hours of directed instruction per unit of credit (i.e., 30 hours of directed instruction for a 2-unit course; 60 hours of directed instruction for a 4-unit course). For more information, please refer to the Standards for Directed Instruction document.

2 Units = 30 Hours of Directed Instruction

Directed Instruction Activity	**Hours**
In-Class Instruction	16
Synchronous Instruction	0
Asynchronous Instruction	14
TOTAL	30

Weekly Homework Assignments

All homework assignments (see below) should be submitted in the corresponding section found in the Assessments folder on the Coursework page for this course in 2PEP.

Week	**Homework**
Week 1: Part 1	Please answer the following questions: a) Give an example in which a decision was complicated because of difficult preference trade-offs. Give one that was complicated by uncertainty. b) Can you think of some different alternatives that Rice's board might consider for controlling the $4 million deficit?
Week 1: Part 2	Read the following case example and answer the questions stated within: Patrick's luck had changed overnight – but not his skill at mathematical reasoning. The day after graduating from college he used the $20 that his

	grandmother had given him as a graduation gift to buy a lottery ticket. He knew his chances of winning the lottery were extremely low and it probably was not a good way to spend this money. But he also remembered from the class he took in business analytics that bad decisions some- times result in good outcomes. So, he said to himself, “What the heck? Maybe this bad decision will be the one with a good outcome.” And with that thought, he bought his lottery ticket. The next day Patrick pulled the crumpled lottery ticket out of the back pocket of his bluejeans and tried to compare his numbers to the winning numbers printed in the paper. When his eyes finally came into focus on the numbers they also just about popped out of his head. He had a winning ticket! In the ensuing days he learned that his share of the jackpot would give him a lump sum payout of about $500,000 after taxes. He knew what he was going to do with part of the money, buy a new car, pay off his college loans, and send his grandmother on an all-expenses paid trip to Hawaii. But he also knew that he couldn’t continue to hope for good outcomes to arise from more bad decisions. So, he decided to take half of his winnings and invest it for his retirement. A few days later, Patrick was sitting around with two of his fraternity buddies, Josh and Peyton, trying to figure out how much money his new retirement fund might be worth in 30 years. They were all business majors in college and remembered from their finance class that if you invest p dollars for n years at an annual interest rate of i percent then in n years you would have p(1+i)^n dollars. So, they figure that if Patrick invested $250,000 for 30 years in an investment with a 10% annual return, then in 30 years he would have $4,362,351 (i.e., $250,000(1+ 0.10)^30). But after thinking about it a little more, they all agreed that it would be unlikely for Patrick to find an investment that would produce a return of exactly 10% each year for the next 30 years. If any of this money is invested in stocks, then some years the return might be higher than 10% and some years it would probably be lower. So, to help account for the potential variability in the investment returns Patrick and his friends came up with a plan; they would assume he could find an investment that would produce an annual return of 17.5% seventy percent of the time and a return (or actually a loss) of -7.5% thirty percent of the time. Such an investment should pro- duce an average annual return of 0.7(17.5%)+ 0.3(-7.5%)=10%. Josh felt certain that this meant Patrick could still expect his $250,000 investment to grow to $4,362,351 in 30 years (because $250,000(1+0.10)^30 = $4,362,351). After sitting quietly and thinking about it for a while, Peyton said that he thought Josh was wrong. The way Peyton looked at it, Patrick should see a 17.5% return in 70% of the 30 years (or 0.7(30)=21 years) and a -7.5% return in 30% of the 30 years (or 0.3(30)=9 years). So, according to Peyton, that would mean Patrick should have $250,000 (1+0.175)^2(1-0.075)^9=$3,664,467 after 30 years. But that’s $697,884 less than what Josh says Patrick should have.

	After listening to Peyton's argument, Josh said he thought Peyton was wrong because his calculation assumes that the "good" return of 17.5% would occur in each of the first 21 years and the "bad" return of -7.5% would occur in each of the last 9 years. But Peyton countered this argument by saying that the order of good and bad returns does not matter. The commutative law of arithmetic says that when you add or multiply numbers, the order doesn't matter (i.e., X+Y=Y+X and X*Y=Y*X). So, Peyton says that because Patrick can expect 21 "good" returns and 9 "bad" returns and it doesn't matter in what order they occur, then the expected outcome of the investment should be $3,664,467 after 30 years. Patrick is now really confused. Both of his friends' arguments seem to make perfect sense logically—but they lead to such different answers, and they can't both be right. What really worries Patrick is that he is starting his new job as a business analyst in a couple of weeks. And if he can't reason his way to the right answer in a relatively simple problem like this, what is he going to do when he encounters the more difficult problems awaiting him the business world? Now he really wishes he had paid more attention in his business analytics class. So, what do you think? Who is right, Joshua or Peyton? And more importantly, why?
Week 2: Part 1	Are the following objective functions for an LP model equivalent? That is, if they are both used, one at a time, to solve a problem with exactly the same constraints, will the optimal values for X1 and X2 be the same in both cases? Why or why not? MAX: 2X1 + 3X2 MIN: -2X1 - 3X2
Week 2: Part 2	Oakton Manufacturing makes two types of rocking chairs specifically designed for men and women known as the His and Hers models. Each chair requires four legs and two rockers but differing numbers of wooden dowels. Each His chair requires four short dowels and eight long dowels while each Hers chair requires eight short dowels and four long dowels. Each His chair contributes $10 in profit while each Hers chair contributes $12. The company has 900 legs, 400 rockers, 1200 short dowels, and 1056 long dowels available. The company wants to maximize its profit while also ensuring that it makes at least half as many His chairs as Hers chairs. a) Formulate an LP model for this problem. b) Sketch the feasible region for this problem.

	c) Find the optimal solution.
Week 3: Part 1	Decision analysis can be used on itself! What do you want to accomplish in studying decision analysis? Why is decision analysis important to you? In short, what are your fundamental objectives in studying decision analysis? What are appropriate means objectives? Is your course design consistent with your objectives? If not, how could the course be modified to achieve your objectives?
Week 3: Part 2	Thinking about fundamental objectives and means objectives is relatively easy when the decision context is narrow (buying a telescope, renting an apartment, choosing a restaurant for dinner). But when you start thinking about your strategic objectives—objectives in the context of what you choose to do with your life or your career—the process becomes more difficult. Spend some time thinking about your fundamental strategic objectives. What do you want to accomplish in your life or in your career? Why are these objectives important? Try to create a fundamental-objectives hierarchy and a means- objectives network for yourself. If you succeed in this problem, you will have achieved a deeper level of self-knowledge than most people have, regardless of whether they use decision analysis. That knowledge can be of great help to you in making important decisions, but you should revisit your fundamental objectives from time to time; they might change!
Week 4: Part 1	A stock market investor has $500 to spend and is considering purchasing an option contract on 1,000 shares of Apricot Computer. The shares themselves are currently selling for $28.50 per share. Apricot is involved in a lawsuit, the outcome of which will be known within a month. If the outcome is in Apricot's favor, analysts expect Apricot's stock price to increase by $5 per share. If the outcome is unfavorable, the price is expected to drop by $2.75 per share. The option costs $500, and owning the option would allow the investor to purchase 1,000 shares of Apricot stock for $30 per share. Thus, if the investor buys the option and Apricot prevails in the lawsuit, the investor would make an immediate profit. Aside from purchasing the option, the investor could (1) do nothing and earn about 8% on his money, or (2) purchase $500 worth of Apricot shares. a) Construct cumulative risk profiles for the three alternatives, assuming Apricot has a 25% chance of winning the lawsuit. Can you draw any conclusions? b) If the investor believes that Apricot stands a 25% chance of winning the lawsuit, should he purchase the option? What if he believes the chance is only 10%? How large does the probability have to be for the option to be worthwhile?
Week 4: Part 2	The national coffee store Farbucks needs to decide in August how many holiday-edition insulated coffee mugs to order. Because the mugs are dated, those that are unsold by January 15 are considered a loss. These premium mugs sell for $23.95 and cost $6.75 each. Farbucks is uncertain of the demand. They believe that there is a 25% chance that they will sell 10,000 mugs, a 50% chance that they will sell 15,000, and a 25% chance that they will sell 20,000.

<table>
<tr><td></td><td>a) Build a decision tree to determine if they should order 12,000, 15,000, or 18,000 mugs. Be sure that your model does not allow Farbucks to sell more mugs than they ordered.
b) Now, assume that any unsold mugs are discounted and sold for $5. How does this affect the decision?</td></tr>
<tr><td>Week 5:</td><td>Let us return to the Texaco-Pennzoil example from Chapter 4 and think about Liedtke's risk attitude. Suppose that Liedtke's utility function is given by the utility function in Table 14.5.

<table>
<tr><th>Payoff (Billions)</th><th>Utility</th></tr>
<tr><td>$10.3</td><td>1.00</td></tr>
<tr><td>$5.0</td><td>0.75</td></tr>
<tr><td>$3.0</td><td>0.60</td></tr>
<tr><td>$2.0</td><td>0.45</td></tr>
<tr><td>0.0</td><td>0.00</td></tr>
</table>

a) Graph this utility function. Based on this graph, how would you classify Liedtke's attitude toward risk?

b) Use the utility function in conjunction with the decision tree sketched in Figure 4.2 to solve Liedtke's problem. With these utilities, what strategy should he pursue? Should he still counteroffer $5 billion? What if Texaco counteroffers $3 billion? Is your answer consistent with your response to part a?

c) Based on this utility function, what is the least amount (approximately) that Liedtke should agree to in a settlement? (Hint: Find a sure amount that gives him the same EU that he gets for going to court.) What does this suggest regarding plausible counteroffers that Liedtke might make?</td></tr>
<tr><td>Week 6</td><td>Even without a formal assessment process, it often is possible to learn something about an individual's utility function just through the preferences revealed by choice behavior. Two persons, A and B, make the following bet: A wins $40 if it rains tomorrow and B wins $10 if it does not rain tomorrow.

a) If they both agree that the probability of rain tomorrow is 0.10, what can you say about their utility functions?

b) If they both agree that the probability of rain tomorrow is 0.30, what can you say about their utility functions?

c) Given no information about their probabilities, is it possible that their utility functions could be identical?

d) If they both agree that the probability of rain tomorrow is 0.20, could both individuals be risk-averse? Is it possible that their utility functions</td></tr>
</table>

	could be identical? Explain.