SIE-422/522 Engineering Decision Making under Uncertainty
Fall 2023
Syllabus

Class Location and Times:

Classroom: M Pacheco LC, Rm 119
Times: TuTh 12.30-1.45pm
22 Aug – 6 Dec

Description of Course

This course presents the foundations of decision analysis contextualized for engineering work. Students will learn to frame and model engineering problems as decisions that traverse physics by incorporating firm's objectives and the personal preferences of the engineer. In addition, the course will present formal and informal limitations of decision methods traditionally used in engineering, such as rank matrices, and will provide students with alternative theories and methods that foster better decisions. Finally, the course will present the notion of risk assessment and management as inherent to engineering decision making, instead of as an independent engineering process.

Course Objectives:

The purpose of this course is to introduce students to the basic concepts, mindsets, and techniques of decision analysis in engineering settings.

Expected Learning Outcomes:

Having successfully completed this course, the student will be able to:

1. Frame and model engineering problems as decisions.
2. Use the concept of belief to navigate through uncertainty in engineering problems.
3. Reject the distinction between technical and non-technical problems and embrace an integrative approach to engineering that embraces preferences and expected value as the bases for engineering decisions.
4. Know the limitations of traditional engineering decision methods, such as rank matrices, and use decision trees, utility theory, and sensitivity analysis for making engineering decisions.
5. Understand and assess risk as part of the decision analysis activity.

Course Prerequisites or Co-requisites

Pre-requisite: None.

Instructor and Contact Information

Instructor: Dr. Alejandro Salado
Office: ENG 121
Phone: 520.626.0728
Email Address: alejandrosalado@arizona.edu

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    Home Page: https://sie.engineering.arizona.edu/faculty-staff/faculty/alejandro-salado
    Office Hours: By appointment.

Course Text

There are two required textbooks in this course:
1) Howard RA, Abbas A. *Foundations of Decision Analysis*. Pearson, 2016.
2) Kahneman D. *Thinking, Fast and Slow*. Farrar, Straus and Giroux, 2013.

Course Software

Academic license for PrecisionTree from Palisade Corporation or another Software tool will be used. The course is not a tutorial on this or any other software. Students will be expected to familiarize themselves with the toolset and resolve problems independently. Students are encouraged to collaborate on making best use of the tool set. A discussion forum in D2L will be set up for this purpose.

Remote students must also use a drawing enabled device during the semester so that they can contribute to group discussions and with the overall class in virtual whiteboards.

Course Format and Teaching Methods

All course information is located on the course homepage, which is in Desire2Learn at **https://d2l.arizona.edu/**. **NOTE:** The course site includes information about the course structure, dynamics, and grading beyond that reported in this syllabus. All students must review such information in advance of class.

The course will use a flipped classroom instructional approach. The student will read the required material and attempt to complete the homework on their own before coming to class.

A detailed schedule of the different activities during the semester will be posted in D2L.

In addition to all policies and information in this document, the instructor expects of every student in this course the following:
- Be aware of all assignment due dates, including reading assignments, and read assigned materials.
- To participate in class discussions.
- To manage the learning process – seek clarification and feedback if needed.
- To complete assignments on time and in a professional manner.
- To demonstrate courtesy and respect to peers and instructor.

Grading Scale and Policies:

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The grading scheme for this course is based on showing mastery of learning objectives. Specifically, these learning objectives will be assed throughout the semester:

LO1. The student is able to correctly explain fundamental concepts in decision analysis, including:
- LO1.1 Decision vs outcome.
- LO1.2 Thought vs action.
- LO1.3 What constitutes a good decision.
- LO1.4 Sunk cost.
- LO1.5 The role of probability in decision making.
- LO1.6 Distinctions vs decisions.
- LO1.7 Alternatives vs possibilities and their definition constraints.
- LO1.8 Clarity vs uncertainty.
- LO1.9 Belief.
- LO1.10 Value of a decision.
- LO1.11 Expected value.
- LO1.12 Utility.
- LO1.13 Fundamental vs means objectives.
- LO1.14 Rules of actional thought (axioms of decision theory).
- LO1.15 Risk attitude.

LO2. The student is able to model and analyze simple decision trees from structured problems:
- LO2.1 Correctly identify decision objective.
- LO2.2 Correctly identify decisions and their alternatives.
- LO2.3 Correctly identify distinctions and their possibilities.
- LO2.4 Correctly model the structure of the decision tree.
- LO2.5 Correctly characterize the decision tree.
- LO2.6 Correctly compute the expected value of the different alternatives.

LO3. The student is able to model and analyze complex decision trees from unstructured problems:
- LO3.1 Correctly identify decision objective. (Includes correctly eliciting an objectives hierarchy.)
- LO3.2 Correctly identify decisions and their alternatives.
- LO3.3 Correctly identify distinctions and their possibilities. (Includes correctly estimating expert beliefs.)
- LO3.4 Correctly model the structure of the decision tree.
- LO3.5 Correctly characterize the decision tree.
- LO3.6 Correctly compute the expected value of the different alternatives.

LO4. The student is able to use advanced concepts of decision analysis:

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- LO4.1 Elicit a utility function. (Includes correctly assessing the risk attitude of the decision maker.)
- LO4.2 Correctly compute the utility of different alternatives in a decision tree.
- LO4.3 Model the value of information for multiple information sources.
- LO4.4 Perform a sensitivity analysis of a decision.
- LO4.5 Evaluate deterministic and probabilistic dominance in a decision model.
- LO4.6 Explain how decision analysis deals with intuition.
- LO4.7 Model a decision problem using a decision (influence) diagram.

The attainment of learning objectives will be mapped to letter grades for the course as follows:

Grade	Description	Standard
E	failure	Not all of the learning objectives LO1 have been demonstrated. *The student is not able to explain all the fundamental concepts of decision analysis studied in this course.*
D	poor	At least all learning objectives LO1 have been demonstrated. *The student is able to explain all the fundamental concepts of decision analysis studied in this course.*
C	satisfactory	At least all learning objectives LO1 and LO2 have been demonstrated. *The student is able to explain all the fundamental concepts of decision analysis studied in this course and can model and analyze simple decision trees from structured decision problems.*
B	good	At least all learning objectives LO1, LO2, and LO3 have been demonstrated. *The student is able to explain all the fundamental concepts of decision analysis studied in this course and can model and analyze simple and complex decision trees from structured and unstructured decision problems.*
A	excellent	All learning objectives have been demonstrated. *The student is able to explain all the fundamental concepts of decision analysis studied in this course and can model and analyze simple and complex decision trees from structured and unstructured decision problems using advanced decision analysis concepts.*

In addition, SIE 522 students must demonstrate the ability to apply decision analysis in a realistic context to attain an A grade. This will be demonstrated by completing a final,

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take-home project. Students will be given multiple days towards the end of the semester to complete the project. Students must complete the project individually, must not collaborate or compare results with other students, and must document any external resources (e.g., literature) they use to complete the project.

Students can demonstrate attainment of learning objectives at any time during the semester. Planned tests and other assignments are listed and described in D2L.

Students in SIE 422 may take a final exam on the assigned timeframe (https://registrar.arizona.edu/finals).

If a student believes there are errors in the grading, they should be reported in written to the instructor within 10 days of receiving the graded assignment.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy: Provide within the acceptable time period for disputing a grade on a paper, project, or exam.

University policy regarding grades and grading systems is available at: http://catalog.arizona.edu/policy/grades-and-grading-system

Lecture schedule

The lecture schedule is provided in D2L.

Participation

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: **http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop**. The UArizona policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, see: **http://policy.arizona.edu/human-resources/religious-accommodation-policy**. Absences pre-approved by the UArizona Dean of Students (or Dean Designee) will be honored. See: **http://policy.arizona.edu/employmenthuman-resources/attendance**.

Classroom Behavior Policy:

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g.,

texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Mainly from the university classroom policy (adopted by the Faculty Senate):
- Not leaving early. Early leaving will distract both the instructor and students
- Not talking with other classmates while the instructor or another student is speaking. If a student has a question or comment, he or she should raise a hand, rather than starting a conversation about it with a neighbor
- Not packing backpacks to leave until the instructor has dismissed class
- Showing respect and concern for others by not monopolizing class discussion. Students must allow others time to give their input and ask questions. Students should not stray from the topic of class discussion
- Not eating and drinking during class time

Academic Integrity and Code of Academic Integrity:

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/policies/code-academic-integrity. The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement. Instructor and/or TA will carefully exam all of your homework, reports and exams to prevent plagiarism. For example:
- No copy of other people's homework i grading your homework, TA will exam all of your homework carefully and catch anyone who is copying other people's homework. Even if they are from the same software's output, TA can still judge whether it is a copy of others or not based on your writing and formatting.
- No copy or discussion in the exam TA and other students all will report these behaviors in exams and your exam papers will also be checked carefully for any cheating behavior. Do not sit too close to each other in the exam.

Teaching Assistant's Responsibility

TA is mainly responsible for assisting the instructor in various issues, including grading homework/quizzes/exams, teaching part of software and tutorial, and helping students in programming and homework during the office hour.

Send Feedback to US:

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If you have any questions, suggestions or comments related to the class, you are very welcome to contact the instructor or TA. We have several ways for communications:
1) In-class feedback
2) Office hours
3) Emails
4) Individual appointment (if you cannot come in office hour)
5) Feedback in D2L

Threatening Behavior Policy:

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See: https://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students

UArizona Nondiscrimination and Anti-harassment Policy:

The University is committed to creating and maintaining an environment free of discrimination, see: **http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy**.

Inclusive Excellence is a fundamental part of the University of Arizona's strategic plan and culture. As part of this initiative, the institution embraces and practices diversity and inclusiveness. These values are expected, respected and welcomed in this course. This course supports elective gender pronoun use and self-identification; rosters indicating such choices will be updated throughout the semester, upon student request. As the course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect.

Additional Resources for Students Statement: Office of Diversity
http://diversity.arizona.edu/
http://www.health.arizona.edu/counseling-and-psych-services

[Accessibility and Accommodations](for students with Disability)

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options.   You are also encouraged to contact Disability Resources (520-621-3268,   https://drc.arizona.edu/) to establish reasonable accommodations.

Requests for incomplete (I) or withdrawal (W)

Must be made in accordance with University policies, which are available at **http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete** and **http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal** respectively.

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Additional Resources for Students

UArizona Academic policies and procedures are available at
http://catalog.arizona.edu/policies
Student Assistance and Advocacy information is available at
http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Subject to Change Statement

The information contained in the course syllabus, may be subject to change, as
deemed appropriate by the instructor, see **http://policy.arizona.edu/faculty-affairs-and-academics/course-syllabus-policy-undergraduate-template**.