# IE 435 Decision Analysis

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#### Aims and Objectives

This course aims to build the foundation of decision analysis and decision making for Industrial Engineering students. At the end of the course, the students shall acquire basic knowledge about decision element, decision models, uncertainty, risk, utility theory and decision under uncertainty. The content of the course includes; Heuristics, Decision making with and without probabilities, Statistical Decision Theory, Utility Theory, measuring utility function and the use utility function for decisions, decision trees, tochastic dominance and efficient frontier analysis for decision makers.

Background

- Introduction to **Decision Analysis**
- Heuristics
- Uncertainty, Probability and Statistics: Review

Decision with Finite Discrete Outcomes

- Statistical **Decision Theory** 
  - Decision without Probabilities
  - Decision with Probabilities: Expected Value
- Utility Theory, Utility Function
- Measuring Utility Single/Multi Attribute
- Decision Trees

- *Constructing* Trees for simple problems
- Solving Decision Trees: Maximizing Expected Monetary Value
- Solving Decision Trees: Maximizing Expected Utility
- Value of Perfect Information
- Decision Trees as a tool for Data Classification/Prediction
  \* How to Learn Tree Parameters for Real Valued Problems

## \* Entropy, Mutual Information

Decision Between Finite Discrete Outcomes and Infinite/Continuous Outcomes

- Approximations for Continuous Random Variables
  - 3-Point Approximation
  - 5-Point Approximation

Decision with Infinite/Continuous Outcomes

- Simulation Review: Monte Carlo Method
  - Monte Carlo Methods
  - A Simple Integration Tool
  - Monte Carlo for More Complicated Problems
  - Steps for Simulation
- Stochastic Dominance
  - + First Degree (Order): Non-satiable decision makers
  - + Second Degree (Order): Non-satiable and Risk Averse decision makers
  - + Discussion:  $N^{th}$  Degree Stochastic Dominance

Decision with Infinitely Many Continuous Outcomes \* Efficient Frontiers

- Applications
  - Portfolio Theory
  - Frontiers/Efficiency Analysis

## **References and Suggested Readings**

- [Main] Making Hard Decisions with DecisionTools, R.T. Clemen, T. Reilly, Cengage Learning, 2014.
- [Important] **Decision Analysis for Management Judgement**, Paul Goodwin, Geoge Wright (3rd Edition, 2004, or Later)
- Thinking and Deciding, J. Baron
- W.L. Winston, Operations Research: Applications and Algorithms, Cengage Learning, 2003
- Statistics for Business and Economics, Paul Newbold, W. Carlson and B. Thorne (*Statistical Decision Theory Chap 19*)

## Assessments and Grading

- $HW(s) \le 30\%$
- $Midterm \leq 30\%$
- $Final \ge 40\%$

Note: In-Class contribution will be considered