Spring 2015

Engineering Decision Support and Expert Systems - Colorado State University

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ENGR 520
ENGINEERING DECISION SUPPORT AND EXPERT SYSTEMS

***Credits*:** 3

Offered: Spring Semester

***Instructor*:** John W. Labadie
Department of Civil and Environmental Engineering
office: B211 Engineering
email: labadie@engr.colostate.edu

***Prerequisites*:** ENGR 510 or equivalent, or consent of instructor

Text: No required textbook--Instructor Class Notes and Handouts provided

***Reference Texts*:**
Turban, E. and J. Aronson, *Decision Support Systems and Intelligent Systems*, Prentice-Hall, 2005 [ISBN 0-13-089465-6]
Collette, Y. and P. Siarry, *Multiobjective Optimization: Principles and Case Studies*, Springer-Verlag, 2005 [ISBN 3-540-40182-2]
Tsoukalas, L. and R. Uhrig, *Fuzzy and Neural Approaches in Engineering*, John Wiley & Sons, 1997 [ISBN 0-471-16003-2]

***Time/Place*:** 2:10-3:25 TR; C140 Clark Building

Grading*: *(approx.)
30% Weekly homework assignments
30% Midterm examination
40% Final class project
[*Term grades for this course will use the +/- grading system as described in the CSU catalog*]

***Objectives*:** The student is introduced to development of decision support systems (DSS) for application to complex engineering management and design problems under conflicting objectives and uncertainty. A number of techniques are introduced for aiding in the analysis of a wide range of complex multiobjective engineering problems. Several stochastic optimization methods are presented for including risk and reliability in engineering design. Basic concepts of expert systems (ES) are discussed to show an essential synergy between DSS and ES for development of decision support structures that allow inclusion of human domain knowledge, heuristics and fuzzy logic. Heuristic methods such as genetic algorithms and particle swarm optimization are offered as a means of solving complex engineering design and management problems that defy traditional techniques of mathematical programming and operations research. Machine learning methods using artificial neural networks are introduced for solving complex dynamic scheduling and control problems in engineering. Each student is required to present a final class project involving application of the tools and concepts presented in the class to a real-world engineering decision problem.

Wk	Topics
1.	Introduction to engineering decision support systems; Normative vs. descriptive approaches in decision analysis
2.	Basic concepts in multiobjective analysis; Multicriteria decision making; Nondominated solutions; enrichment of dominance relations based on intensity of preference
3.	Discrete outranking methods; MAUT and weighted average method; PROMETHEE family of methods
4.	Discrete outranking methods; ELECTRE family of methods; Applications
5.	Analytical Hierarchy Process (AHP); Compromise programming; Group decision making; Applications
6.	Methods for generating nondominated solutions; Stationarity conditions; Weighting method
7.	Epsilon constraint method; Goal Programming; Applications
8.	Introduction to stochastic multiobjective programming; 2-stage stochastic programming with recourse; Risk analysis
9.	Stochastic programming with probabilistic constraints; Chance constrained programming
10.	Introduction to expert systems; Knowledge representation; Production rules
11.	Inference mechanisms—backward and forward chaining; Presentation of expert system development tool
12.	Uncertainty and fuzzy logic operators; Fuzzy rules and rule systems; Fuzzy multiobjective optimization; Applications
13.	Introduction to genetic algorithms (GA); Selection, crossover, mutation, and replacement operations in GA; evolutionary algorithms
14.	Applications of GA; multiobjective GA; MOGA, NSGA-II, Swarm intelligence methods; Particle swarm and Ant Colony
15.	Introduction to neural networks; Backpropagation and radial basis ANN; Hopfield and recurrent networks; Applications to dynamic scheduling and control of engineering systems